POWER

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High-Class Power Plant Engineers

IN looking over an accumulation of correspondence for a suggestion for a subject I came upon two letters.

One comments upon the slowness of advancement of engineers in power plants, and contrary to the usual tenor of such communications, reproves the disposition of those who are passed over in the process of selection to berate the boss and calumniate the appointee.

Dispassionate analysis of the causes that led to the failure of preferment to fall upon them might not only have a mollifying effect upon their disappointment but indicate some of their own shortcomings.

It is for the boss's interest to get things done. He cannot do everything himself and the success of his business or his success in his position depends upon getting about him an effective organization.

He is not content with things as they are. He has visions of growth and plans for development. When an occasion arises for a change in important personnel he naturally looks for somebody who will be of greater use to him, upon whom he can lean harder, who most nearly conforms to his ideal man for the job.

The man who has simply held a job down and kept it running for years, just getting along, who has never given the boss a helpful suggestion, who does not see his job and its possibilities in a big way, is likely to be passed over for one with ideas and the personality to impress them.

The other letter is from an official of a large coal company, and urges the more general recognition of the power plant engineer in an executive capacity.

He has evidently got under their skins and found out more of their capabilities than have their superior officers.

I know power plant engineers who, given a free hand in their department, could save a lot of money and who could bring to bear upon the conduct of the mechanical operations of the business a lot of sound common sense.

But some of them would look funny out with the boss or sitting at a directors' table.

The power plants that have survived the weeding-out process of recent years and those that will still be installed and persist are, and will be, of sufficient importance to warrant the superintendence of a high-class of man.

And they will be filled by men who in their thinking, their attainments, their appearance and personality, measure up to, and exemplify, the importance of the power department in industry.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

A Word to Power Plant Executives

THERE is need for closer co-operation between power plant owners and the equipment manufacturers.

Too often the manufacturer is obliged to build his equipment to exacting guarantees without the background of complete operating tests. Under this handicap he does his best with the information available from his experiments and experience, supplemented by what he knows of the experience of others.

Probably he is confident of his ability to make good, but his guarantees have necessarily been conservative. Certainly he wishes more actual performance data were available upon the important problems he has committed himself to solve.

On completion of the plant, the owner generally confines his tests to the bare requisites necessary to determine the acceptability of the equipment.

If the performance is satisfactory, the incident is closed as far as he is concerned.

The manufacturer, however, is left with mixed feelings: relief that his work is finished, and an unsatisfied desire to know the exact operating characteristics and the limitations of his product, so he may systematically plan for improvement in future constructions.

Power plant executives should realize that a broad and liberal policy of co-operation with the manufacturers, in the securing of actual operating information, will also be an important step in their own interest.

Noise and the Engineer

THE engineer must become "noise-conscious." Having trained himself to be affected as little as possible by the roar of turbines, the musketry of riveters working in boiler shops and on steel buildings, the uncalled-for blatancy of steam-shovel exhausts, and the reverberation of trains on steel trestles, he is prone to forget that these noises are undesirable from the public welfare point of view, and that they are, in part at least, preventable. The engineer thinks in terms of heat units, speeds, ultimate strengths and elastic limits, rates of flow, and dollars and cents, not merely because these things are important, but also because he has been *taught* to think of them. If he encounters no mention of noise as an engineering problem in his college course, and hears little *about* it (although plenty *of* it) in later years, it is but natural that he should pass it by as unimportant.

But this attitude must change; in fact, is now changing. As a definite indication one may cite the appointment last week of a "Noise Commission of New York." The personnel of this commission, as selected by city Health Commissioner Wynne, promises something worth while. Manufacturing is represented by Lewis H. Brown, president of Johns-Manville Corporation, and law by Charles C. Burlingham. Arthur H. Duel, Foster Kennedy, S. T. Kopetzky and Frederick Tilney will take care of the medical phases as experts on ears and nerves. The engineers will note with pleasure that their profession is represented by Dr. Harvey Fletcher, research engineer with the Western Electric Company and author of many works on sound.

In view of the fact that engineers design and construct all of the devices that make the noises—as well as those that don't—it might seem that one engineer out of seven members is insufficient representation. However, the fact must be faced that the first job is to find out what noises really impede the operation of the human machinery and how much, and how. After that the engineers can proceed intelligently to reduce this damage.

Pending the study of reports that may be issued by this and subsequent commissions, it is safe for any engineer to apply common sense to the elimination of objectionable noises under his own control.

Emergency-Service Equipment

INSUFFICIENT attention is being given to the continuity of power supply by engineers and architects of hotels, office buildings, public buildings, and other institutions offering services to people. Seemingly, it is thought that responsibility ends with the provision of a single source of power, properly designed and connected and with means for its efficient operations.

There is more involved than this. A service must be provided that will take into account the factors of public convenience and safety. A temporary stopping of power and lighting may not cause direct money loss, but may easily lead to extensive damage through a dissatisfied public—may even lead to panic and loss of life.

These are matters against which it is not always possible, and oftimes criminal, to weigh dollars.

Some communities have enacted laws requiring owners to provide emergency equipment to guard against such situations. Investment in machinery for emergency breakdown service in these conditions becomes a duty not measurable in terms of cost only.

It is well for equipment to be independent of the primary power source in every way.

Gasoline engines of large capacity are ideal for the service under some conditions. Oil engines are being

used and are particularly well-suited when an electrical rate is based on peak-load demand, as they offer means of economically carrying the daily peaks in addition to the stand-by emergency service.

Theaters and auditoriums are installing automatic waterwheel-driven lighting sets that take their power-water supply direct from the city mains for emergency lighting service.

Regardless of the method adopted, no organization can afford to accept the responsibility for failure to guard against breakdown in the primary power supply.

Who Is to Use Natural Gas?

THE economist and the engineer will do well to consider what those long, snake-like natural-gas pipe lines now spreading eastward and northward from the Southwest portend for industry.

Are the bituminous coal mines, recovering from the shock of the battle with fuel oil, faced with another struggle—this time with natural gas? Will the use of the gas become so widespread that the Western and the Illinois coal miner will be forced to curtail his operations or sell his black diamonds at ruinous prices? Will demand for the profitable household prepared sizes disappear, leaving the miner only a market for steaming coal, now sold at a loss? Can gas be sold at a price to compete with coal for boiler firing?

Not so many years ago that it is beyond the memory of the majority of *Power's* readers, natural gas was so abundant and cheap in Ohio, Indiana and West Virginia that towns found it more economical to let the street lights burn all day than to employ a lamp lighter. Industry was persuaded to adapt boiler furnaces to the use of gas, as a result of unbelievably low prices. In time the gas supply began to diminish, and in winter the pipe line pressure was barely sufficient to meet the household demand; industries found themselves deprived of the fuel at the time when it was most needed, and soon bituminous coal regained its old-time supremacy. The gas companies had simply been too lavish in their distribution of a limited natural resource.

Can the pipe lines and the nation afford that history's repeating itself in the Southwest? If, as has been announced, the fields will supply the pipe line demands for fifteen years, would it not be better to double this life by limiting the fields of use.

The State of California has, in a measure, anticipated this problem and, by legislation, decreed that gas wells shall not be drilled unless there is an outlet for the gas. So far there have been no limitations as to the character of gas application, and, consequently, natural gas is actively competing with oil on the Pacific Coast as a boiler fuel. Within the past few days orders have been placed for over two hundred miles of pipe line to deliver gas to the power houses and residences of San Francisco. One oil-producing company, in order to be permitted to continue its drilling, has purchased a public utility that requires a large amount of fuel.

Coal burning, to be efficient and smokeless, entails much attention and skill. It is not surprising that smoky chimneys feature nine out of ten Midwestern homes, for the householder cannot give the needed attention to stoking the furnace. On the other hand, the boiler room force of a power plant is employed for the purpose of burning coal efficiently, which means a smoke-free stack.

Consequently, from health and economic viewpoints, natural gas should be reserved for household use, with a percentage for such chemical use as hydrogen recovery. This may seem class discrimination, but the appearance may be avoided through a rising rate schedule whereby the rate per unit of gas is increased with an increase in total consumption.

If the matter is examined closely, one finds that the use of gas under boilers is seldom justified from a cost basis. Exceptions of course exist, as in the case of certain Louisiana power stations, where gas is obtainable at less than five cents a thousand cubic feet. But with pipe line investment, piping costs and distribution expenses, gas should cost over five times that price, at the distant boiler plant.

Bituminous coal at existing market prices will generate steam at a lower cost. But the coal producers would do well to form an engineering force for the instruction of the operators of the smaller industrial places in methods of correct firing.

Maximum Demand In the Industrial Power Plant

MAXIMUM DEMAND plays an important part in the rate structure of most public utilities. It is a logical charge, since the utility must have in its power house sufficient generating capacity to supply peak loads whenever they occur, and such capacity represents, roughly, an investment of $100 a kilowatt.

The large user, because of this rate structure, is interested in keeping the maximum demand as low as possible. Special instruments are installed and various tests run to find a way to lower the peak demand. Often it has been greatly reduced by staggering the operations of various manufacturing departments.

All too frequently, however, no attention is given to peak loads in plants that generate their own power. Maximum demand meters are rarely installed and demand studies seldom made.

The savings possible by reducing peaks and smoothing out load curves are thus neglected because the penalties are not so obvious. High peaks and valleys in the load necessarily mean a loss of efficiency in the power house. Furthermore, they may also require the installation of additional generating capacity which could be postponed or entirely eliminated by giving as much thought to the reduction of maximum demand as do those who purchase central station power.

WITH 208,000-KW. UNIT TUNED UP

STATE LINE STATION

Officially Opened

Exterior of State Line station

First 208,000-kw., three-element unit of 1,000,000-kw. plant is in regular operation. Six boilers supply steam at 600 lb. and 730 deg. F. (throttle). The exhaust passes to eight vertical condensers. Other features include unit pulverizers, steam reheaters, economizers, air heaters, ash sluicing, and coal storage under water.

ALTHOUGH the State Line station, operated by the State Line Generating Company, has been tuning up for the past three months, it was not pronounced officially ready for continuous operation until Oct. 22. As has been known for some time, it is featured by the largest generating unit ever placed in service, the rating being 208,000 kw., including the exciter. The plant has been laid out for a possible five units, giving eventually, as the demand requires, a capacity approximating 1,000,000 kw.

Owned jointly by the Commonwealth Edison Company; the Public Service Company, of Northern Illinois; the Northern Indiana Public Service Company, and the Interstate Public Service Company, the new station, which is operated by the State Line Generating Company, will wholesale electrical energy to these four companies in proportion to their ownership. Switching of the electricity will be done in an outside switchyard, containing a number of original features. The current is taken away at 33,000, 66,000 and 132,000 volts. The 132,000-volt energy goes to the Public Service Company, of Northern Illinois, and the Northern Indiana Public Service Company; the 66,000-volt current is delivered to the Commonwealth Edison Company through underground cables; and the 33,000-volt output has been allotted to the Northern Indiana Public Service Company.

The plant was built entirely on filled-in ground, projecting into Lake Michigan a distance of 1,200 ft., the location being on the Indiana side of the line between Illinois and Indiana. Excellent rail facilities are available for the delivery of coal. With the lake to draw from, the water supply is abundant and of good quality. Condenser cooling water is pumped directly from the lake through tunnels to the turbine room, and is returned to the lake some distance from the intake. The longitudinal section of the plant shows the crib house, which contains four vertical circulating pumps driven by motors mounted well above lake level. The pumps are in watertight compartments, with the suction lines passing through the wall of the intake chamber. Through bar grills and traveling screens, this chamber is supplied from a forebay formed by a breakwater built out into the lake.

With so much water to be had at the cost of pumpage, it was found economical to sluice the ashes from the boiler furnaces to a pit in an ash house outside the main building, from which they are lifted by a bucket crane into railway cars. Storage of coal under water was also readily feasible. Preparations have been made to store 125,000 tons of coal, part of this under water, but space is available to quadruple the storage capacity.

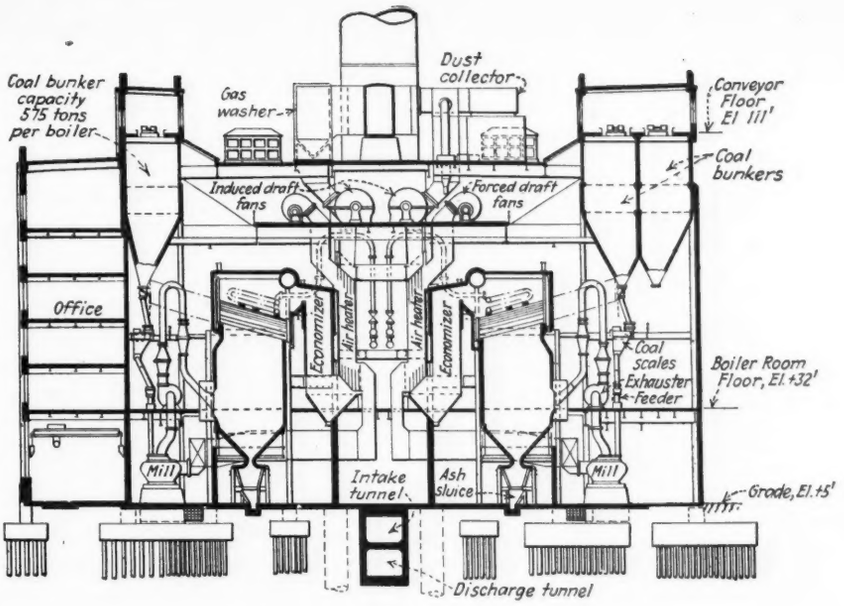
In a plant of this character, wholesaling current in large blocks, economy and flexibility were the primary factors in the design. Following recent practice in Insull properties, the pressure at the throttle was made 600 lb. gage, with a steam temperature of 730 deg. F. At the superheater outlet the pressure is 50 lb. higher, and the final steam temperature is 750 deg. When the plant was laid down these steam conditions were considered as high as it was commercially economical to go for a major machine of the size decided upon.

Excellent economies are indicated in the performance diagram. The turbine heat rate is 9,850 B.t.u. per kilowatt-hour. Adding 650 B.t.u. for the auxiliaries, brings the total for the unit to 10,500 B.t.u. per kilowatt-hour. With a boiler room efficiency of 85 per cent and an operating efficiency ratio of 92 per cent, the over-all rate for the station should approximate 13,420 B.t.u. per kilowatt-hour. It is expected that this performance will be improved upon.

A unit larger than any that had been installed in the past was chosen because some increase in economy was anticipated from its great size. The magnitude of the systems served permitted large machines, especially since

considerable flexibility was made possible by installing a triple unit, consisting of a high-pressure element driving a 76,000-kw. generator, which exhausts at about 115 lb. abs., pressure into two low-pressure machines. Each low-pressure turbine drives a 62,000-kw. generator and a 4,000-kw. house generator supplying the plant auxiliaries. The three machines may operate as a unit or each low-pressure element independently, with the high-pressure element shut down, as live steam connections have been carried to the low-pressure turbines.

Between the high- and low-pressure elements the steam is reheated, in live steam reheaters, to 500 deg. F., some 200 deg. below the initial temperature. Thus economies are somewhat less than would be maintained with reheat boilers, but the installation is somewhat simpler, and being less expensive will yield a satisfactory return.

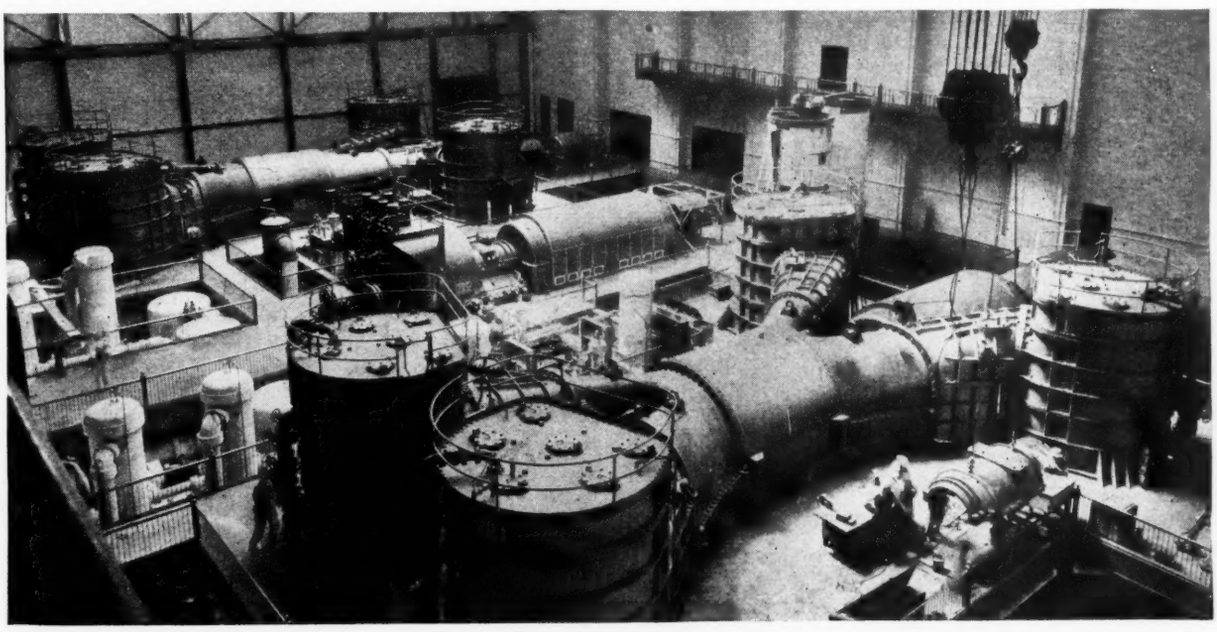


Cross-section through the boiler room

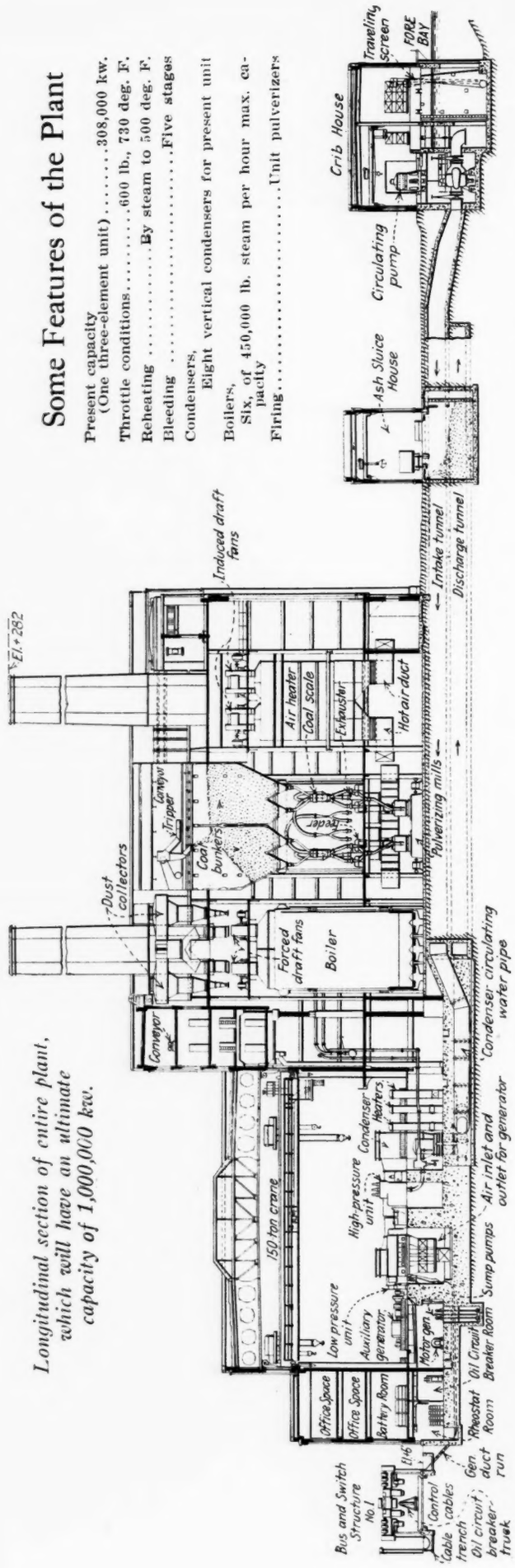
The machine would seem to cover large floor area, but calculations show the volume of the present turbine room in cubic feet per kilowatt to be 13.9, an exceptionally low figure, indicating efficient use of available space. Reference to the table of equipment will show that a high boiler room adds 18.6 cu.ft. of volume per kilowatt, and, including switch house, crib house and offices, the building volume of the plant per kilowatt totals 38.7 cubic feet.

The turbine unit is arranged for five stages of bleeding for feed-water heating, two from the high-pressure element, at 231 and 140 lb., abs.; one from the high-pressure exhaust, at 73 lb. abs.; and two from the low-pressure turbines, at 30 and 6 lb. abs. The balance of the steam exhausts into eight vertical single-pass surface condensers each with 22,000 sq.ft. of surface. Four condensers serve each low-pressure turbine. Condensate from the condenser hot wells is forced through these heaters in series, the drains being cascaded back from one heater to the other in the order of decreasing pressure and, finally, pumped back into the system. Between heater Nos. 2 and 3 eight-stage boiler-feed pumps force the water on through the high-pressure heaters and economizers to the boilers. These pumps are built to operate against a head of 2,050 ft. at capacities of 900 gal. per minute. Single-effect evaporators of the vertical contra-flow type supply the necessary make-up water.

Such excellent results had been obtained in the trial powdered-coal unit installed at Calumet station some three years ago that the six boilers in the initial installation at State Line are practically duplicates, except that they are much larger, each having a maximum capacity to deliver 450,000 lb. of steam per hour at 650 lb. pressure and a total temperature of 750 deg. F. The boilers are of the horizontal cross-drum single-pass type, with a water-heating surface of 10,294 sq.ft. in two-tube banks. Wider spacing predominates in the lower bank, to pre-



View of turbine room, showing the 208,000-kw. three-element machine



Longitudinal section of entire plant, which will have an ultimate capacity of 1,000,000 kw.

vent slag formation and to expose maximum surface to the radiant heat of the fire. A full water-cooled furnace, with 4,441 sq.ft. of surface, connected into the boiler circulation, has a volume of 22,500 cu.ft., or nearly 2.2 cu.ft. per square foot of boiler surface. A difference in elevation of 64.5 ft. between the basement floor or grade level and the center of the cross drum gives an indication of the great height of the furnace.

Above the tubes is a convection type superheater having 7,200 sq.ft. of surface. Behind the boiler is a steaming economizer of the counterflow loop type having 19,820 sq.ft. of surface, and a tubular air heater of the single-pass counterflow design, with inclined tube sheets, between which are installed 56,401 sq.ft. of surface. Air preheated from 350 to 400 deg. F. in this heater is partly for primary use, passing through the mills after being tempered with cold air, and the balance is secondary air introduced into the boiler furnace around the burners. Summarizing, the heating surfaces of the component parts of each boiler unit are:

Boiler surface, sq.ft.	10,294
Furnace heating surface, sq.ft.	4,441
Economizer surface, sq.ft.	19,820
Total water surface, sq.ft.	34,555
Air heater surface, sq.ft.	56,401

Great capacity, flexibility to meet sudden demands, high economy and ease of operation are the essential characteristics that made this arrangement of boiler unit desirable for the new station. The boilers are equipped for automatic control.

Unit mills were given preference over a central system. Two 70-in. mills of the pusher type, with capacities ranging from 15 to 17 tons per hour, were installed per boiler. The location is on the basement floor in line with the crushed coal bunker, at the top of the boiler room.

Two of the mills are operated by Rossman drives, something new in this field, providing a most flexible means for varying the speed evenly over wide limits. The drive consists of a direct-current motor revolving the field of the alternating-current motor driving the mill. If the field on the alternating-current motor is revolved backwards, the mill turns slowly. If the field is held stationary, the mill assumes an average speed. If the field is revolved ahead the mill moves faster, so that low, intermediate and high speeds are readily obtained by the simple process of rotating the field of the alternating-current motor. Directly above the mills on the boiler-operating floor are the exhausters, which

Under-water storage for 125,000 tons of coal

deliver to the furnace through eight vertical burners of the Calumet type adapted for horizontal firing.

The cross-section through the boiler house shows the simplicity and compactness of the design. The six boilers are arranged in two rows of three boilers each, with a stack at each end serving three boilers. The boilers are back to back, so that the mills and the bunkers are on the outside. Between the boilers are the economizers and air heaters, as indicated, and between the opposing air heaters is a pipe gallery carrying the boiler leaders to a combination header and separator at the turbine room wall. From the separator two pairs of leads, divided in this way for flexibility, combine through special Y-fittings into two supply lines to the steam chest of the high-pressure turbine. Taps from these lines lead to each low-pressure turbine, so either of the low-pressure elements may be operated independent of the high-pressure machine.

In a convenient location between air heaters and stacks, at an elevation of 85 ft. 6 in., are the forced- and induced-draft fans. There are two forced-draft fans, of turbo-vane type, with vane control to supply a total of 120,000 cu.ft. of air per minute to each furnace. Gases from each boiler unit are removed by double-inlet turbo-

Principal Mechanical Equipment, Unit No. 1, State Line Station

Location ..... Hammond, Ind.
Water source ..... Lake Michigan
Service ..... Power and light
Capacity, present 208,000
Ultimate Kw. 1,000,000
Area property, acres 90.1
Owners ..... State Line Generating Co.
Consulting engineers ..... Sargent & Lundy Co.

Present building — Vol. Cu. Ft. Per Kw.

Boiler room	18.6
Turbine room	13.9
Switch house	1.5
Crib house	1.4
Office	3.3
Total	38.7

Standard boilers, six ..... Babcock & Wilcox Co.
Water heating surface, sq.ft. 10,294
Superheat, surface, sq.ft. 7,200
Steam press. supht., outlet, lb. g. 650
Steam temp. supht. outlet, deg. F. 750
Steam cap. max., lb. per hr. 450,000
Furnace volume, cu.ft. 22,500
Furnace side wall surf., sq.ft. 4,441
Economizers, steel contraflow, ... Babcock & Wilcox Co.
Surface, sq.ft. 19,820
Air heater, tubular ..... Babcock & Wilcox Co.
Surface, sq.ft. 56,401
Furnace, refractory and metal ..... Bailey Wall
Pulverized fuel eqpt. ..... Fuller-Lehigh Co.
Twelve 70-in., mills, air separation with exhauster fans
Mills per boiler 2
Capacity of mill, tons per hr. 15-20
Mills Burners, 8 per boiler— ..... Calumet type
Turbine-generator, one ..... General Electric Co.
Total cap. unit, kw. 208,000
Steam pressure at throttle, lb., g. 600
Steam temp. at throttle, deg. F. 730
Steam press. at reheat, full load, lb. abs. 115
Steam temp. to l.p. turbines, deg. F 500
Generator voltage 22,000
Speed, r.p.m. 1800
Feed-water heaters, five vertical, floating head — Griscom-Russell Co.
Condensing equipment ..... Allis-Chalmers Mfg. Co.
Condensers, 8 vertical, single-pass
Surface each, sq.ft. 22,000
Condensing cap., lb. per hr. 200,000
Circulating water pumps, four, 60 x 60 in., single stage, vertical, 95,000 g.p.m. each, head 15 ft., 190-r.p.m., motor drive. Condensate pumps, six, 10 x 5 in., 3-stage, centrifugal, 1000 g.p.m. each head 580 ft., 1750 r.p.m. motor drive
Air ejector pumps, one Croll-Reynolds, 16 first-stage ejectors, 4 combined inter and after coolers, 12 second-stage ejectors, capacity 42 c.f.m. at 1 in. abs.; steam consumption, 1950 lb. per hr.
Forced-draft fans ..... B. F. Sturtevant Co.
12 turbovane, vane control, cap. each 60,000 c.f.m., against 7.5 in. static pressure, speed 1,160—870 r.p.m., motor drive
Induced-draft fans ..... B. F. Sturtevant Co.
12 double-inlet, turbovane, capacity 110,000 c.f.m., with max. gas temp. of 400 deg. and static pressure of 10.5. in., speed 865-690 r.p.m., motor drive
Boiler-feed pumps ..... Worthington Pump & Mach. Corp.
Six motor-driven, 5-in., 8-stage, volute, 900 g.p.m. each, 2050 ft. head, 1760 r.p.m.
Four turbine-driven 6-in 6-stage centifugal, 900 g.p.m. each, 2,050 ft. head, 1760 r.p.m. DeLaval Steam Turbine Co.
Heater drain pumps ..... A. S. Cameron
Four 3-stage, 500-g.p.m. each, head 250 lb. per sq.in., 1,800 r.p.m.
Bilge pumps ..... Yeomans Bros. Co.
Two in turbine room, vertical, centrifugal, 250 g.p.m. each, 20 ft. head, 1,150 r.p.m., motor-driven
Two in crib house, vertical centrifugal, 250 g.p.m., 40 ft. head, 1,150 r.p.m., motor-driven
Five 5-in. volute, centrifugal, 1,200 g.p.m. each,
Service Pumps ..... Worthington Pump & Mach. Corp.
183-ft. head, 1,750 r.p.m., 4 motor-and 1 turbine-driven
Fire pumps ..... Worthington Pump & Mach. Corp.
One 5-in., 4-stage, volute, 1,000 g.p.m. each, 505 ft. head, 1,750 r.p.m., motor-driven
Boiler wash pump ..... Worthington Pump & Mach. Corp.
One 4-in., 3-stage, 600 g.p.m., 600-ft. head, 1,750 r.p.m., motor-driven
Ash-sluicing pumps ..... Worthington Pump & Mach. Corp.
Two volute, centrifugal, 1,200 g.p.m. each, 183-ft. head, 1,750 r.p.m. motor-driven
Reheater drain pumps ..... A. S. Cameron
Two 3-stage, 125 g.p.m., 300-lb. head, 3,500 r.p.m., motor-driven
Evaporator condenser drain pumps ..... Worthington Pump & Mach. Corp.
Two volute, 4-stage, 80-g.p.m., 1,750 r.p.m., motor-driven
Automatic combustion control ..... Leeds & Northrup Co.
Boiler settings ..... Nat. Pr. Cons. Co.
Flues, uptakes, air ducts ..... Henry Pratt Co.
Evaporators ..... Foster-Wheeler Corp.
Two vertical contraflow evaporators and one vertical floating head evaporator condenser, capacity 40,000 lb. dis. water per hr.
Water filter system ..... Paige & Jones Chem. Co.
Eight units, gravel and filter tank, 150 g.p.m.
Turbine room cranes ..... Whiting Corp.
Two double-trolley, main hoist 75 tons, aux. hoist 15 tons, span 130 ft., lift 67 ft. 3 in.
Air compressors ..... Sullivan Mach. Co.
Two 2-stage, angle-compound, 610 c.f.m., 225 r.p.m., 100 lb. pressure, motor-driven
Coal-handling equipment, 500 ton per hr. ..... Koppers Co.
Belts, 42 in. wide, speed 360 ft. per min.
Two 250-ton per hr. Bradford breakers ..... Penn. Crusher Co.
One car dumper, 60-ft. rotary, 120 tons max. — Link Belt Co
One track scale ..... Fairbanks, Morse & Co.
Coal-storage equipment ..... R. H. Beaumont Co.
Drag line scraper, 300 ton per hr., 200 ft. per min.
Feed-coal scales ..... Richardson Scale Co.
12 automatic, apron feed, 15 to 20 ton per hr. each.
Ash-handling equipment, ash hoppers, gates and hydrojet
Handling ..... Allen-Sherman-Hoff Co.
Economizer arches, suspension, refractory .... Bigelow-Liptak Corp
Traveling screens ..... Link Belt Co.
Five screens, 92 in. wide, center distance, 35-½ ft. speed 10 ft. per min.
Miscellaneous steel and iron work .... Vierling Steel Works
Coal-transfer car, 75 tons ..... McMyler Interstate Co.
Dust collectors, Vorticose, two; normal gas capacity, 110,000 c.f.m. at 355 deg.; maximum gas capacity 220,000 c.f.m.; pressure drop at maximum rating 1.75 in; recovery expected, 82 per cent
Sirocco dust collectors, four normal gas capacity, 160,000 c.f.m. at 350 deg., maximum gas capacity 220,000 c.f.m.; pressure drop at maximum rating, 2.78 in. ..... American Blower Co.
Cinder traps, two, nominal gas capacity 160,000 c.f.m. maximum gas capacity 220,000 c.f.m. pressure drop at maximum rating 0.07 in.; recovery expected, 86-88 per cent ..... Green Fuel Economizer Co.
Piping system ..... W. A. Pope
Piping, duct, boiler insulation ..... Johns-Manville Corp.
Vacuum cleaning system, two unit, 75-inlet valves ..... Atwood-Stewart Vac. Mach. Co.
Outdoor and indoor switching equipment, General Electric Co.
Transformers ..... General Electric Co.
Miscellaneous motors ..... Allis-Chalmers Mfg. Co.
Automatic telephones ..... Automatic Tel. Co.
Motor-operated gate valves ..... Crane Co.

vane fans having a combined capacity to exhaust 220,000 cu.ft. per minute.

Effort was made to prevent pollution of the atmosphere with ash and dust from the powdered coal furnaces. Dust collectors of three different types, handling the gases dry, were placed on the roof. Each collector receives the gas from one boiler. The collectors function by centrifugal separation or by passing the gases through inclined baffling with vortex chambers leading down to the dust hopper at the bottom, or through rows of horizontal, wavy, perforated baffles. It is expected to install collectors of the electrical-precipitation type on the remaining three boilers.

One of the features of the plant is a comprehensive coal-handling system that eventually will be called upon to supply over 1,000 tons per hour. The installation for the first unit consists of a 60-ft. rotary car dumper with a maximum capacity to handle 20 cars of coal per hour. To control traffic to and from the car dumper, special car-pushing and car-retarding devices have been provided, the former consisting of a "mule" traveling on a special track between the car rails and operated by a $1\frac{5}{8}$-in. steel cable. The retarder consists of pneumatically operated brakes that press against the car wheels as the car passes down the incline.

From the hopper of the car dumper the coal for immediate use is carried by belt conveyor to the breaker house and from there passes up on inclined belt conveyors to the top of the boiler house, where it is transferred to distributing belts running over the coal bunkers. If the coal is to go to storage, delivery is made at the breaker house to a special hopper discharging to a car of the bottom dump variety, which transfers the coal to a second hopper, the latter spouting it to the edge of the under-water storage. From this point a drag-line scraper distributes the coal. Reclaiming is accomplished by the same scraper into a pit from which an inclined conveyor leads to an elevated hopper. The transfer car removes the coal to the car unloader, where it is introduced into the system to pass through the breakers on into the boiler house.

Reducing Internal Cooling Of Boiler Units

By E. Praetorius
Berlin

WHERE boilers are operated at irregular intervals, as is generally necessary in industrial plants, the cooling losses during idle periods become of considerable importance. Tests made by the writer in a rubber factory showed that only a relatively small loss is caused by radiation from the exterior boiler surface during stand-by periods. There is a much greater loss, however, due to interior radiation and to cooling of the furnace chamber and flues.

During interruptions in service the chimney sucks large quantities of air from the furnace chamber through the damper, which, in practice, always leaks more or less. This air is replaced by cold air entering by way of the grate openings, through cracks around the furnace doors, peep holes, etc. After being heated in the furnace chamber, this air is drawn up the chimney, thus causing the large quantities of heat stored up in the brickwork to be unprofitably dissipated.

To overcome this difficulty, the Union Gesellschaft Wärmetechnik m.b.H., Berlin, has brought out a draft check invented by the German engineer Stober. This damper, though simple in design, isolates the boiler from the chimney, thereby eliminating boiler and furnace cooling by internal radiation.

The accompanying diagram shows the principle of the invention. As will be seen, the furnace chamber *1* is connected to the chimney *3* by the uptake *2*. During interruptions in service, the usual sliding damper *4* and a second gate *5* form a chamber *6* in the uptake. This communicates, by a valve *7*, with the external air. The air valve *7* is connected to the gate by a rope running over a pulley, and automatically opens when the gate *5* is closed, while during operation it remains closed. Even if the damper leaks, as usually it does, this arrangement prevents the air from being sucked through the interior of the boiler.

Gate *5* is a special casting of a low coefficient of expansion and has only a small amount of play in its frame. Experience has shown that this shut-off will remain tight. Even if it should develop some small leak, however, the interior of the boiler will nevertheless remain isolated from the chimney flue, since the leakage will be supplied by outside air passing into space *6* through valve *7*.

This check draft has been tried out in many plants and has given excellent results. One of these installations was made at the Tiefstack Power Station, of the Hamburg Electric Company, in connection with a Duerr water tube-boiler of 6,500 sq.ft. of heating surface.

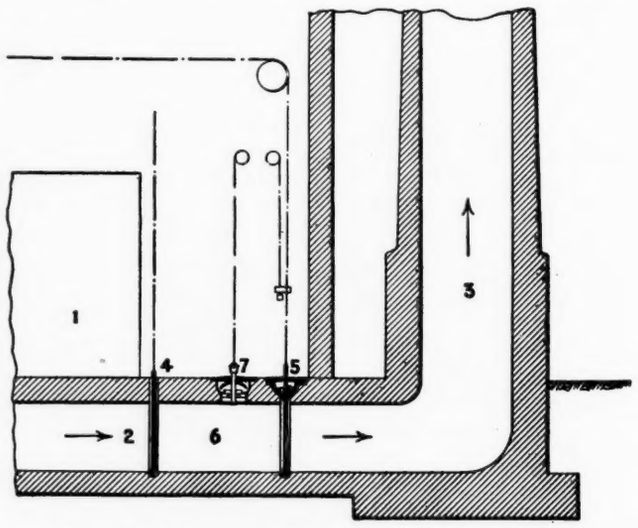


Fig. 1—Diagram of draft check installation
1 Boiler. 2 Uptake. 3 Chimney. 4 Regular damper. 5 Second gate. 6 Chamber. 7 Air valve.

Comparative tests with and without the damper were made to determine the savings. Although the management had already taken pains to reduce cooling losses to the lowest possible figure by constant watching and frequent overhauling of the regular damper, by careful calking of the brickwork, and similar measures, operation of the new damper raised the efficiency by 3.8 points, from 78.2 to 82 per cent. The equivalent saving of coal was about 300 tons per year.

Incidental advantages obtained by the use of the draft check are a substantial reduction in the time required for the preliminary warming-up of a boiler, and reduction in repair expenses for boiler materials, due to the elimination of extreme changes in temperature.

Cooling Refractories in BOILER FURNACES

Part One—THE THEORY

By Ralph A. Sherman
Fuel Engineer, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa.

The service life of a refractory wall may often be prolonged if the temperature is reduced by cooling with air, water or steam. Even though the temperatures attained by refractories in boiler furnaces are below their softening temperatures, they deform under load and are subject to attack by slag.

NORMALLY, a refractory wall does not seriously deform under the load of the wall above, because the temperature gradient through the wall is such that enough of the brick is at a low temperature, and consequently rigid enough to bear the load. In the high walls of present-day large furnaces, if the entire load is carried to the bottom courses, the pressure per square inch may reach such values that the temperature of deformation falls much below the temperature near the surface of the wall. For such walls an increase in the temperature gradient through cooling by the passage of air through a channel in the wall may be the means of maintaining a rigid wall.

For each combination of a given coal ash and refractory there is a certain temperature at and below which little erosion will occur, but above it the wall is rapidly attacked. No exact measure of this critical temperature is yet available, but some indication is given by the fusibility of the coal ash as determined by the cone test. The critical temperature is exceeded in many installations, and slag erosion is by far the most serious cause of refractory failure.

Slags of the erosive type do not appreciably penetrate the refractories, and erosion occurs at, or very near, the surface. The cooling of a refractory wall must therefore reduce the surface temperature if it is to be effective in the reduction of erosion. The rate of erosion increases with increase in temperature above the critical temperature; therefore, any reduction in the surface temperature of the wall will tend to reduce the rate of erosion. If the temperature can be reduced to the critical temperature, erosion will be stopped. For severe conditions—that is, high ratings and low excess air, with consequent high temperatures, and easily fusible ash, the necessary reduction in the surface temperature to the critical temperature may be several hundred degrees.

There are three considerations which merit discussion: (1) The relation of temperature to service. (2) The principles of the transfer of heat to and from refractory walls. (3) The practical aspects of the construction of air- and water-cooled walls. In this week's article the first two of these are considered. In Part Two, to appear next week, the practical side of the question will be treated.

Aside from the reduction in severity of the service of refractories, which is considered here as its primary purpose, the cooling of the walls by air or water presents other important advantages. In air cooling, the air which is heated in the walls is generally used for combustion, and thus the efficiency of the combustion process may be increased. Also, the temperature of the outer wall or casing of the furnace is lowered, hence the loss by radiation and convection may be reduced.

The installation of water tubes behind the refractories adds to the steam-generating capacity of the boiler, and, like air cooling, reduces the radiation and convection loss from the furnace. If the design is such as to obtain high rates of heat transfer relative to the rate of heat liberation, the furnace temperature will be lowered and slagging of the boiler tubes may be reduced.

The interior surfaces of walls of a boiler furnace are heated by radiation from the fuel bed, flame, and gases, and by convection from the gases. At the temperatures attained in furnaces, the greater part of the transfer is by radiation. Heat is transmitted through the refractory wall by conduction, and from the outer surface of the wall to the air by convection and radiation; the portion transmitted by radiation increases rapidly as the temperature rises.

Table I gives the rate of heat transfer from a furnace at 2,800 deg. and 2,400 deg. F. to the surface of the wall for temperatures of the hot surface of 10 to 100 deg. F. below the temperature of the furnace; an emissivity of 0.9 was assumed. The phrase, "temperature of the furnace," is used to cover the temperature of the flame, fuel bed, and gases, as the actual temperature which governs the rate of transfer is a composite of these and experimental data on their individual values are lacking.

Table I shows that if the hot surface of the wall is to be maintained at as much as 100 deg. F. below the temperature of the furnace, a rate of heat transfer through the wall of 20,500 B.t.u. per square foot per hour must be maintained if the furnace is at 2,800 deg. F., and 13,800 B.t.u. per square foot per hour if at 2,400 deg. F.

When a condition of thermal equilibrium is reached, the amounts entering, transferred through, and leaving

the wall are equal. This is expressed by the following equation:

(1)

Heat to hot surface = Heat through refractory = Heat to air

$$Q = 1.723 \times E \left[\left(\frac{T_f}{1{,}000} \right)^4 - \left(\frac{T_{hs}}{1{,}000} \right)^4 \right] = k \frac{(t_{hs} - t_{cs})}{d} = c_a (t_{cs} - t_a)$$

Where Q = rate of heat transfer, B.t.u./sq.ft./hr.
E = emissivity
T_f = absolute temperature of flame, fuel bed, or gases, deg. F.
T_{hs} = absolute temperature of hot surface of wall, deg. F.
t_{hs} = temperature of hot surface of wall, deg. F.
t_{cs} = temperature of cool surface of wall, deg. F.
t_a = temperature of air, deg. F.
k = conductivity of refractory, B.t.u./sq.ft./hr./deg. F./in.
c_a = rate of heat transfer from the cool surface to the air, B.t.u./sq.ft./hr./deg. F.
d = thickness of wall, in.

The value assumed for the emissivity E is a composite of the radiation and convection from the gases and radiation from the fuel bed, flame, and other walls, also the radiation from the wall to the exposed heating surface. All of these components have values which vary with the size of the furnace, the relative position of the surfaces, the type and amount of solid matter carried in the gases and their velocity over the surface. The value, 0.9, assumed is, therefore, only for the purpose of illustration.

The temperature of the hot surface of a furnace wall for a given furnace temperature depends on the over-all coefficient of heat transfer, c_o, from the furnace to the air, which is made up of the three coefficients:

(2)

$$c_o = \frac{1}{\frac{1}{c_f} + \frac{d}{k} + \frac{1}{c_a}}$$

The values for c_f have been shown in Table I to be 137 to 214 B.t.u. per square foot per hour per degree F. for the range covered.

Table II shows the values for k according to the results of Norton,[1] whose are the most reliable and complete available domestic materials. The values are those for the given temperatures; mean values may be obtained by inspection of a curve plotted from the data. The maximum value for fireclay bricks is 12, and the relatively small difference between the values for the two kinds given suggests that there is little choice between fireclay bricks as to difference is conductivity. Other kinds of bricks that are used in boiler furnaces for which values are given are kaolin, the least porous of which has a conductivity of 20, fused alumina whose maximum conductivity is 30, and silicon carbide, whose conductivity decreases with increase of temperature from 127 at 1,112 deg. to 75 at 2,552 deg. F.

TABLE I—HEAT RADIATED TO SURFACE OF WALL AT VARIOUS TEMPERATURES, B.T.U./SQ.FT./HR.

	t_f, Deg. F.			
	2,800		2,400	
$t_f - t_{hs}$	Q	c_f*	Q	c_f*
10	2,140	214	1,440	144
20	4,250	212	2,865	143
30	6,355	212	4,280	143
40	8,430	211	5,675	142
50	10,495	210	7,050	141
100	20,505	210	13,750	137

*c_f = coefficient of transfer, B.t.u./hr./sq.ft/deg. F.

TABLE II—THERMAL CONDUCTIVITY OF REFRACTORIES
(B.t.u./sq.ft/hr./in. thickness/Deg. F.)

Sample No.	Kind of Brick	Porosity, Per Cent	Temperature, Deg. F. 392	752	1,112	1,472	1,852	2,192	2,552
1	Missouri	18.4	7.0	8.7	10.2	10.7	11.3	11.9	12.2
2	Pennsylvania	26.7	7.0	7.8	8.7	9.3	9.9	10.4	10.7
3	Kaolin	10.8	13.6	15.1	16.3	17.4	18.6	19.4	20.3
4	Kaolin	23.2	9.9	11.0	11.9	12.5	13.1	13.6	13.9
5	Kaolin	49.1	3.2	4.4	5.2	5.8	6.4	6.7	7.0
6	Silica	30.4	8.1	10.2	11.6	12.8	13.9	15.1	15.7
7	Chrome	30.5	9.9	10.7	11.3	11.6	11.6	11.9	11.9
8	Magnesite	31.6	39.8	36.3	29.9	27.6	26.1	25.2	24.7
9	Spinel	36.3	10.4	11.6	12.2	13.1	13.6	14.2	14.8
10	Fused alumina	21.3	18.0	21.5	23.8	25.8	27.6	29.3	30.5
11	Zirconia	29.5	10.2	11.3	12.2	12.8	13.3	13.9	14.2
12	Silicon carbide	35.3	....	....	127.7	110.3	95.8	84.2	75.5

COMPOSITION OF THE BRICKS

Kind	SiO_2	Al_2O_3	Fe_2O_3	CaO	TiO_2	ZrO_2
Missouri	53.1	43.3	2.5	0.6	....	....
Pennsylvania	54.2	38.8	2.7	....	2.7	....
Kaolin (3, 4, 5)	52.0	45.9	1.5	....	0.4	....
Silica	97.0	....	....	....	....	....
Spinel	....	65.0	....	26.0	....	....
Zirconia	27.3	7.8	1.6	....	....	60.4

The coefficient, c_a, of the transfer of heat from the cool surface of a wall depends on the temperature of the surface, on the temperature of the air and surrounding objects, and on the velocity of the air. Reliable data show for still air at 90 deg. F., c_a has a value of 1.5 to 31.1 for temperature differences of 100 deg. to 2,000 deg. F. There is some discrepancy among the values of different investigators for the variation of the coefficient with the velocity of the air. Using the formula of Langmuir,[2]

(3)

$$Q_{cv} = Q_c \sqrt{\frac{V + 68.9}{68.9}}$$

Where Q_{cv} is the rate of heat transfer by convection at a velocity of V feet per minute and Q_c is the rate of heat transfer by convection in still air. For air at 90 deg. F., and at a velocity of 1,200 ft. per minute, c_a has values of 2.6 to 35.9 for surface temperatures of 100 deg. to 2,000 deg. F. It will be noted that the difference in the values of c_a for still and moving air is much less at the high temperatures. This is caused by the rapid increase in the fraction of the heat transferred by radiation, which the moving air does not affect.

If the values of one of the three resistances, the reciprocals, of equation 2 are much greater than the other two, this becomes the principal factor which determines the over-all coefficient. Take for example two 18-in. walls with still air on the cool side, one of firebrick, $k = 10$, the other of silicon carbide, $k = 100$, with an effective furnace temperature of 2,800 deg. F.; the over-all coefficients will be about as follows:

$$c_{o_1} = \frac{1}{\frac{1}{217} + \frac{18}{10} + \frac{1}{3.6}} = \frac{1}{0.0047 + 1.8 + 0.28}$$

$$c_{o_2} = \frac{1}{\frac{1}{211} + \frac{18}{100} + \frac{1}{8.9}} = \frac{1}{0.0046 + 0.18 + 0.112}$$

In the first example the resistance of 18 in. of firebrick is so much the greatest of the three resistances that

[1] Norton, F. H., Jour. Amer. Cer. Soc., Vol. 10, 1927, page 30-52.

[2] Langmuier, I., Convection and Radiation of Heat, Trans. Am. Electrochem. Soc., Vol. 23, 1913, pages 299-330.

relatively large changes in the other two would not materially affect the over-all value. In the second example the resistance of the silicon carbide and the resistance of the surface are of similar order, and similar changes in either would be about equally effective in changing the over-all coefficient. In both examples, however, the resistances of the wall and at the cool surface are much greater than that at the hot surface.

Table III gives values for the temperature of the hot surface, t_{hs}, and of the cool surface, t_{cs}, of firebrick and silicon-carbide walls 27 to 4.5 inches in thickness for furnace temperatures, t_f, of 2,800 deg. and 2,400 deg., for air temperature, t_a, of 90 deg., and for still air and air at a velocity of 1,200 feet per minute calculated according to equation 1. The temperatures of the hot surface are given to the nearest degree and those of the cool surface to the nearest five degrees.

The temperature of the hot surface of the 27-in. wall

TABLE III—TEMPERATURE OF SURFACES OF WALLS UNDER VARIOUS CONDITIONS

	t_f = 2800 Deg. F., t_a = 90 Deg. F.							
	Firebrick				Silicon Carbide			
	0		1,200		0		1,200	
d	t_{hs}	t_{cs}	t_{hs}	t_{cs}	t_{hs}	t_{cs}	t_{hs}	t_{cs}
27	2,796	380	2,796	255	2,768	940	2,765	780
18	2,794	450	2,794	310	2,755	1,070	2,752	920
9	2,789	610	2,788	460	2,723	1,290	2,717	1,180
4.5	2,779	800	2,777	635	2,675	1,520	2,666	1,430
	t_f = 2,400 Deg. F.,				t_a = 90 Deg. F.			
27	2,395	340	2,395	230	2,361	870	2,358	700
18	2,393	420	2,392	300	2,346	980	2,341	830
9	2,386	560	2,385	410	2,310	1,180	2,300	1,070
4.5	2,374	740	2,371	580	2,256	1,380	2,242	1,290

with air at zero velocity on the cool side is only 4 deg. below the flame temperature when this is 2,800 deg. F., and only 5 deg. lower when it is 2,400 deg. F. The decrease in temperature at the hot face, with decrease in the thickness of the wall, is greater for the furnace temperature of 2,400 deg. than 2,800 deg. F., but is slight with either; for a wall 4.5 in. thick the temperature of the surface is only 21 deg. and 26 deg. F., respectively, lower than the furnace temperatures 2,800 deg. and 2,400 deg. F.

With walls of silicon carbide there are greater differences in the temperature of the hot face and of the furnace; they vary for walls 27 to 4.5 inches in thickness from 32 deg. to 125 deg. for the furnace at 2,800 deg. F., and 39 deg. to 144 deg. for the furnace at 2,400 deg. F. Conversely, the temperatures of the cool surfaces are several hundred degrees higher for the silicon-carbide than for the firebrick walls.

For the firebrick wall and with a furnace temperature of 2,800 deg. F. the temperature of the hot surface of the 27-in. wall is the same for moving as for still air—that is, the difference is less than one degree, although the temperature of the cool surface is 125 deg. F. lower. For the 4.5-in. wall the temperature of the hot surface with moving air is only two degrees lower than that of the same wall with still air. Similar values are found for the furnace at a temperature of 2,400 deg. F.

The effect of the moving air on the temperature of the hot surface of the walls of silicon carbide is also slight; the maximum decrease due to moving air is 12 deg. for the 4.5-in. wall for the furnace temperature of 2,400 deg. F.

These calculated values show that the effect of decrease in the thickness of wall on the temperature of the hot surface was much greater than that of the velocity of the air.

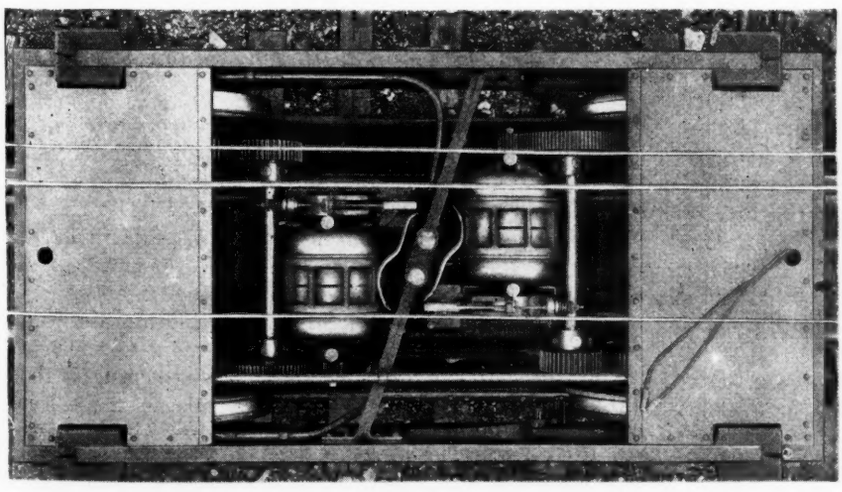
Riderless A.-C. Larry Cars for Handling Coal

By R. F. Emerson
Industrial Engineering Department
General Electric Company

Conditions for stocking and reclaiming coal at some steam generating plants may be such that a system using riderless alternating-current motorized larry cars may work out advantageously. This scheme is now in successful operation in a quarry. The system includes one or more cars propelled by standard high-torque, high-resistance, squirrel-cage motors. The cars are all controlled from one location by one operator.

Each car has two motors, one geared to each of the two axles through a counter-shaft to give the required speed reduction, as in the picture. Each motor has a solenoid brake mounted on the shaft opposite the pinion end. These motors are designed for full-voltage starting, which means that the starting equipment is of the simplest type possible. Either one or several of the cars can be used on the same track, all controlled by one operator, who by throwing a switch causes the line contactor to close and energize certain sections of the track. As soon as a track section is energized, the solenoid brake coil releases and the motor starts on full voltage. The brake stays released and the motor continues to run until the operator either brings his control switch to the "off" position or until the car runs into a dead section of track. When this happens, power is cut off simultaneously from the brake and the motor, causing the brake to set and bring the car to rest. From his operating station, the operator can control several cars merely by throwing small switches.

Because of the well-known sturdiness of the squirrel-cage motor, which has no commutators or slip rings, and the simple method of starting the motors on full voltage by a single magnetic switch, both the first cost and the upkeep of the electrical equipment is reduced to a minimum.



Larry car, body removed, showing motors and gearing

TWO-CYCLE DIESEL

of Unusual Design

Developed by BURMEISTER & WAIN

BURMEISTER & WAIN, famous Diesel builders of Copenhagen, Denmark, are now building two-stroke-cycle solid-injection Diesels with a new and efficient scavenging arrangement. This design is adapted to both the single- and the double-acting engine, the latter is shown in Fig. 1.

The scavenging of many double-acting engines is interfered with by the presence of the large piston rod. As a consequence, combustion in the lower end of the cylinder is poor, resulting in a low mean effective pressure. Port exhaust even for single-acting engines is never satisfactory, the Burmeister & Wain designers claim, since the use of ports in the cylinder for the escape of the hot burnt gases tends to damage the oil film on the cylinder walls, and the expansion of the exhaust port bridge carries a threat of scored piston.

By adopting a plan somewhat similar to that used in gas engines years ago, the exhaust gases are allowed to escape at the ends of the cylinder, while the scavenging air enters through a center belt of ports.

Examination of Fig. 1 shows the arrangement. The upper end of the cylinder is covered by a water-cooled head having a large central cavity into which is placed a piston, or plug valve. The lower cylinder carries a similar valve, which, however, is arranged to encircle the piston rod, and carries the metallic piston-rod packing.

These two valves are coupled together by reach rods, which, in turn, are connected to a yoke-and-bell crank. A connecting rod coupled to an auxiliary crankshaft, chain-driven from the main shaft, is connected to the bell crank and actuates the valve gear.

Taking for example the upper end of the cylinder, which in Fig. 1 is shown in the firing position: As the fuel is injected and burned, the power piston is forced downward on its stroke, and at the same time the rotation of the main shaft causes the gear to move the top-end piston valve upward. In fact, however, the gas pressure exerted upon the crown of the plug valve forces the valve upward, and the force is in turn transmitted to the auxiliary crankshaft and through the chain to the main-shaft. The valve stroke is one-fifth of the working piston's stroke and about 10 per cent of the power of the engine is transmitted through the auxiliary crankshaft from the valve.

As the working piston nears the end of its stroke the piston valve uncovers the row of exhaust ports in the head casting, and the exhaust gases rush out. Immediately afterward the working piston uncovers the central belt of scavenging air ports, and the inrush of air clears the cylinder. The action in the lower piston of the cylinder is identical in principle.

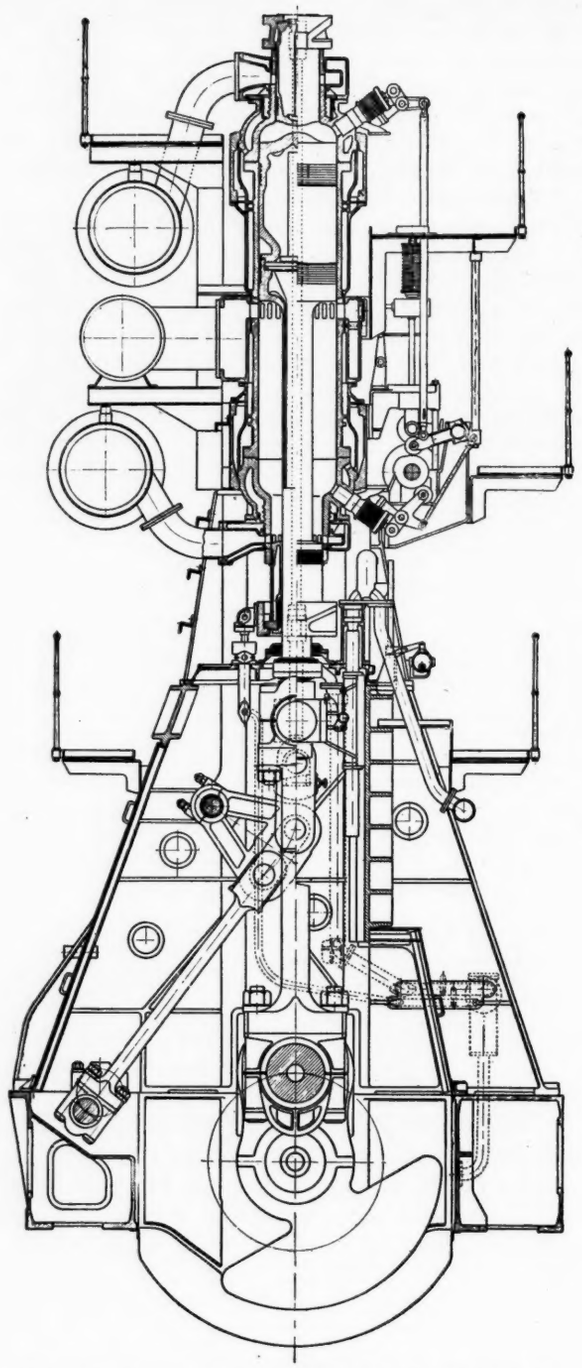


Fig. 1—Cross-section of B. & W. double acting solid-injection Diesel

In the single-acting units, which are made in moderate capacities, the piston valve is driven from the main crankshaft by an eccentric rod. Scavenging air is supplied by a separate double four-wing blower, designed to operate at speeds of about 400 r.p.m.

A somewhat surprising feature of this engine is that although designed presumably for marine purposes, fuel is injected by direct pump pressure through a spring-loaded atomizer and nozzle. It has been the understanding among engineers that where maneuvering is necessary, a needle valve is superior to the spring-loaded

valve, but the designers of this engine claim that the latter valve opens fully at a predetermined pressure and stays open during the pump stroke, thus avoiding wire drawing at opening and closing.

As shown in Fig. 2 the fuel valve is a spring-loaded needle with a rounded seat. The shape of the seat and amount of valve lifts are such that as soon as the pump pressure lifts the needle, the valve opens wide, and when the fuel pump bypass relieves the pressure, the valve snaps closed under the action of the heavy spring. Dribbling is avoided by this design.

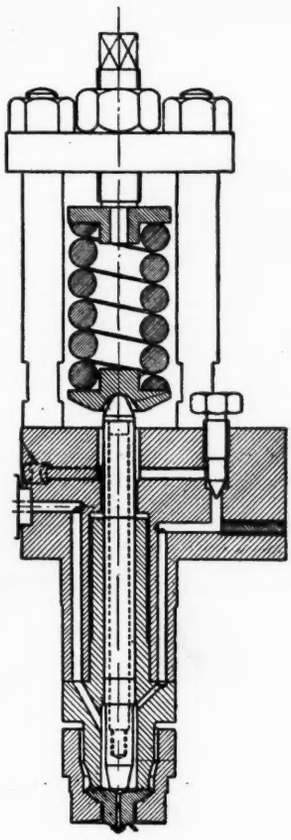


Fig. 2—Design of fuel nozzle

As the exhaust valve occupies the center of the head, the fuel spray valve is placed in a horizontal position, spraying across the combustion chamber. It is not shown in Fig. 1, but it enters the side of the cylinder almost diametrically opposite the air-starting valve. This position is satisfactory, as has been proved by results with the Doxford engine.

To eliminate pressure irregularity and pulsations brought about by long oil lines, the fuel pump is mounted alongside the cylinder head. The fuel pump has a plunger making a fixed stroke and a piston bypass valve made up of a rod carrying a relieved section, which, when registering with a port, permits fuel to be discharged back into the suction line. The time of fuel injection is definite, and the rate of fuel flow is determined by the cam profile. The end of injection is controlled by the bypass valve, which is rotatable by the governor, so that the relief registers with the bypass port in accordance with the load.

River-Boat Boilers No Longer Burst

BOILER explosions aboard vessels engaged in inland waterways transportation appear to have passed into history along with the good old days of Mark Twain and the packet boats. A survey of accidents to such vessels from the records of one of the marine underwriters showed not a single boiler explosion from 1920 to 1927.

At the Eighteenth Annual National Safety Congress in Chicago this excellent condition was attributed to the fact that steamboat inspection regulations were not as rigid, either as to rules or their enforcement, back in the good old days as they are today. The practice now, according to an address at the congress, is to carry lawful steam pressure and water up to the level prescribed by law and experience.

Investigators Study the Causes of Turbine Blade Failures

AN INVESTIGATION of turbine blading troubles, occurring in 100 machines during the years 1926, 1927 and 1928, is recorded in the recent serial report on "Turbines" of the N.E.L.A. Prime Movers' Committee. Most of the machines were of 20,000 kw. or larger, and many had been in operation from two to four years.

The troubles considered include, in addition to blade failures proper, fractures discovered before actual failure, damage to, or loss of, shrouding sections, fractures of lacing wires or soldered lacing wire connections resulting in damage to blades, some root troubles and a few cases of cracked tenons under the shroud bands.

From the information on hand it is possible to group, roughly, turbine blade failures into the two following classifications:

1. Those for which no apparent cause can be found and which apparently bear no definite relation to failures in other machines.

2. Those for which cause is discovered by inspection after the development of trouble, or which apparently bear some relation to similar troubles in other machines.

A large number of failures can be grouped under the first classification.

Often a number of failures may be linked together to form evidence that points to some weakness of design or other probable cause of trouble. Thus may be classed the failures of the longer blades in the lower stages of certain sizes of impulse turbines and of the shorter intermediate blades in reaction machines.

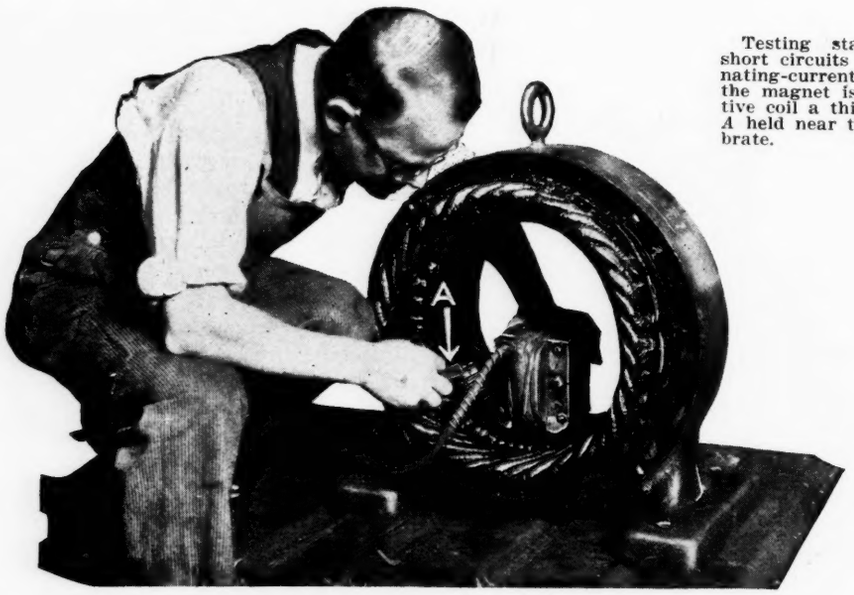
From the evidence available, failures of the longer impulse blading cannot be attributed directly to the primary stresses due to centrifugal force, to impact, to pressure differences across the blading, or to blade loadings. Failures are rather the result of fatigue due to vibration. In a few of the cases reported the failures have been hastened by erosion and corrosion, but it is believed failure would have ultimately occurred from vibration alone.

Failures in reaction machines have appeared in the intermediate sections and on blades and shapes deemed amply strong through years of service. Such failures probably result from a combination of the primary stresses rather than from vibration, which would be more apt to manifest itself in the longer blades. These troubles have resulted in revision of methods of blade calculations to include factors previously deemed unimportant.

Improvement Over Old Materials

The use of Ascoloy, stainless steel or chrome-iron alloy is increasing for replacement as well as for new blades. Of the blading materials thus far developed, chrome-iron alloys apparently best combine the requirements of strength, resistance to erosion and corrosion, reasonable ease of working by ordinary shop methods, possibility of soldering without alteration of structure and reasonable cost.

The use of lacing wires upon replacement of the longer blades is continued. In an effort to stiffen blading some applications of binding wires were made to blade shapes which had shown a tendency to fail through vibration. The application of tie wires to blades that are not primarily designed for their use must be regarded as somewhat experimental.



Testing stator coils for short circuits with an alternating-current magnet. When the magnet is over a defective coil a thin piece of iron *A* held near the coil will vibrate.

LOCATING WINDING FAULTS *in* *Alternating-Current Motors*

By M. E. WAGNER
New York City

Short circuits, open circuits and grounds are three faults in alternating-current motor winding that operating engineers are most likely to have to contend with. The effects of these faults and how to locate the source of trouble are here explained.

TROUBLES that develop in alternating-current motors may be divided into those that are due to faults outside the windings and faults in the windings. The former were discussed in the Sept. 3 number of *Power*. This article will consider the latter.

Where a motor has been operating in a normal manner the faults that can develop in the windings may be classified as short circuits, open circuits and grounds. A machine that has just come from the shop may have a number of other winding faults, such as reversed coils or pole-phase groups. In a three-phase machine a whole phase may be connected wrong. The coils may be incorrectly distributed in the winding. The motor may be wound for the wrong number of poles, or for a voltage other than that given on the nameplate.

Short circuits in alternating-current motor windings may occur under a number of conditions. A short circuit may be between the turns of a single coil; the insulation becomes damaged and allows two or more conductors in the same coil to come into contact with each other. One or more groups of coils may become short circuited, usually by the insulation failing on the end connections. For example, in Fig. 1, if the insulation failed where the end connections cross at x it would short circuit the three coils in A_2 group. On the other hand, if the conductors of the top coil in slot 14 were to come in contact with the conductors in the bottom coil it would cause a short circuit between coil groups B_1 and B_2 and cut part of these groups out of the circuit.

Usually, in alternating-current motor windings, the coils are given a pitch less than full, which brings coils of different phase into the same slot. For example, slot 15 contains one side of a *C* phase coil and one side of a *B* phase coil. If the insulation were to fail between these two coils it would cause a short circuit between phases *A* and *C*. Short circuits can also be caused between phases by insulation failures where the ends of the coils cross or between the end connections.

These short circuits will have different effects on the motor's operation, depending upon where they are located and how good the contact is between the conductors causing the fault. A short circuit between two conductors in the same coil will cause heating of the coil only. One method of detecting this fault is to start the motor cold and allow it to run light for a few minutes and then shut it down. Faulty coils can usually be detected by the difference in temperature between them and the other coils.

One short-circuited coil probably will not cause any unusual effects in the operation of a motor. Where a number of coils are short circuited they will cause excessive heating of the winding, low torque, or, under

certain conditions, a motor may fail to start and blow the fuses even though unloaded.

One way to check an induction motor that is not operating satisfactorily is to measure the current in the different phases. On a two-phase motor two ammeters are required, Fig. 3, and for a three-phase machine, three ammeters should be used, Fig. 4. If it is known that the load will be constant, one ammeter can be used and the meter changed from one phase to another to obtain the different current readings. The current readings in the different phases should be practically the same.

When the current is found out of balance the voltage should be tested to determine if the fault is being caused by unbalanced voltage. The voltage readings should be taken with the motor disconnected. If the voltage is approximately equal across each phase and the current is out of balance, it is safe to assume that a fault exists in the windings.

The no-load current taken by a motor is a good indication of the motor's condition. This current will vary to a considerable extent in a normal motor, being lowest for a high-speed machine. Where the no-load current of a high-speed motor may be around 15 per cent of full-load value, for a slow-speed machine the no-load current may be more than double this value. If the no-load current is abnormally high, it is an indication that something is wrong. This might be caused by worn bearings allowing the rotor to rub on the stator core, or by short circuits or grounds in the windings. Usually, the two latter faults will also cause the current in the different phases to be out of balance.

If the motor is new and takes an excessively large no-load current, it may be that it is wound for the wrong voltage, such as a 220-volt winding in what was intended to be a 440-volt machine. Such mistakes do happen, although rarely.

The well-known drop-of-potential test can be made on the stator windings of an alternating-current machine, but it is more difficult to apply than to direct-current machines. On a three-phase motor the windings are interconnected, and in all cases the ends of the coils are insulated, which makes it difficult to connect the millivoltmeter. If the winding is series-star connected, as in Fig. 1, connecting terminal *A* and * to a source of low-voltage direct current will energize phase-winding *A*, but will leave *B* and *C* dead. After the coils in this phase have been tested, the direct-current lead can be shifted from terminal *A* to *B*, and the latter energized and then tested with the millivoltmeter. Following this, phase *C* can be checked.

To apply the millivoltmeter without taking the insulation off the connections between the coils, the voltmeter leads may be equipped with sharp steel points that will pierce the insulation and make contact with the copper. After the coils have been excited with direct current the millivoltmeter may be applied to the terminals of each coil.

When the coils are grouped in series delta, Fig. 2,

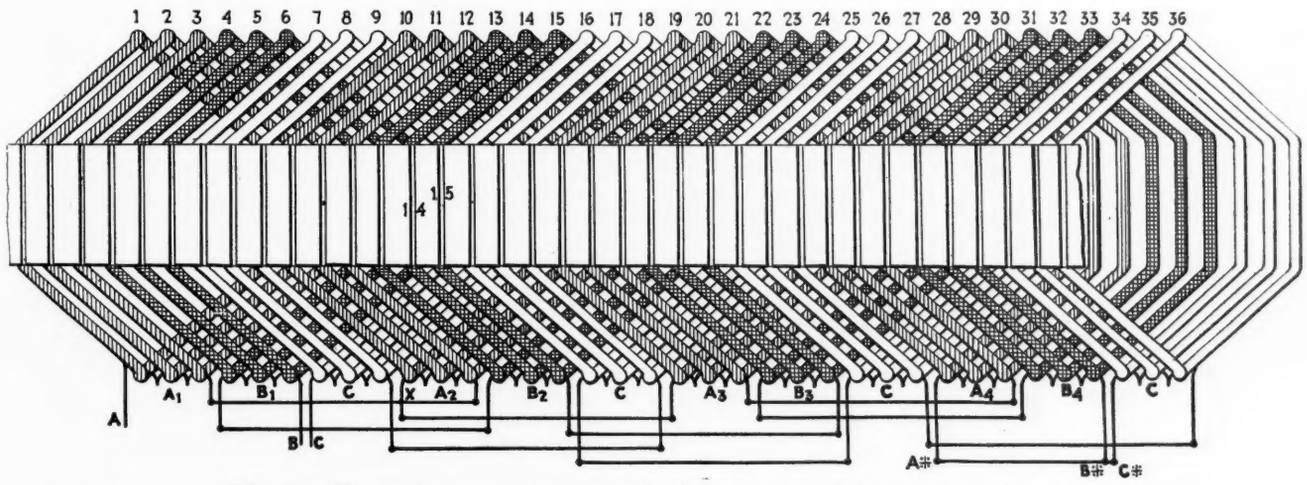


Fig. 1—Alternating-current motor windings connected four-pole series-star

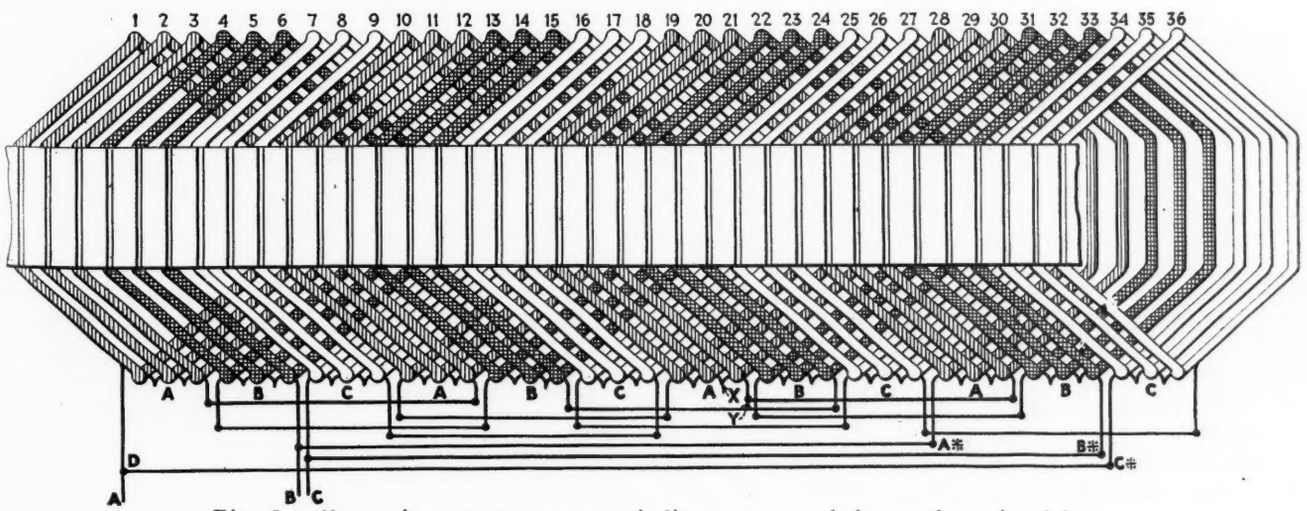


Fig. 2—Alternating-current motor windings connected four-pole series-delta

connecting two of the leads to a source of direct current will energize the whole winding, but two of the phases will carry approximately one-half the current of the other one. This will be made clear by reference to the simplified diagram, Fig. 5. If leads *A* and *B* are connected to a source of power, phase *B* will be directly across the line, but phases *A* and *C* will be in series across the source of power. If the voltage were taken on the terminals of the coils in the winding it would be found that the drop across each coil in the *B* phase would

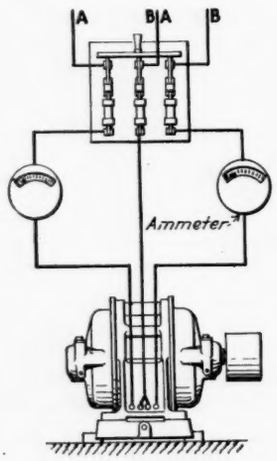


Fig. 3 — Ammeters connected in each phase of a two-phase motor

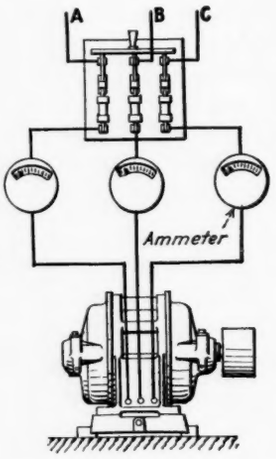


Fig. 4 — Ammeters connected in each phase of a three-phase motor

be about twice that across the coils in the *A* and *C* phases. This can be avoided by opening the connection between two of the phases and connecting the source of direct current to the two leads made by the break.

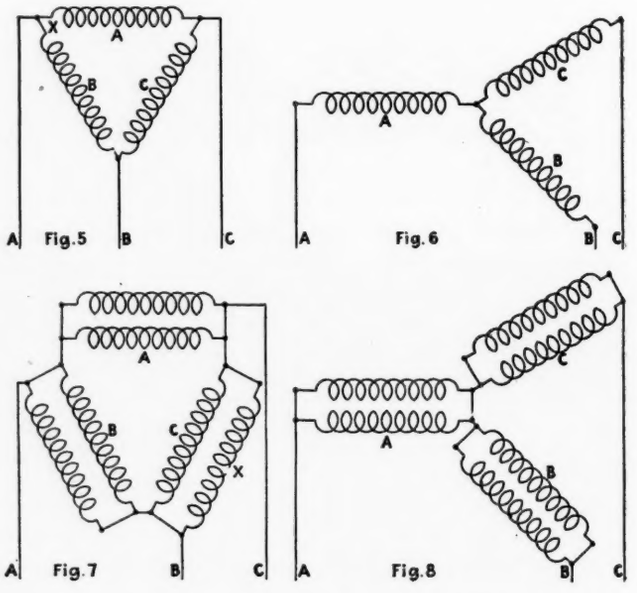
For example, the winding might be opened by breaking the connection between the *A* and *B* phases at *X* and connecting the source of direct current to the free *A* and *B* leads. This would put the three phases in series. All coils would have the same current flowing in them, and, if all were in good condition, they would give the same voltage drop on the meter. A low-reading coil would indicate one that is short circuited. When making this test the current must be adjusted to a value that will give a good reading on the meter, about one-half to two-thirds across the scale.

A better method of locating short-circuited coils is to use a testing magnet, generally known as a growler. This magnet is energized from a source of alternating current and then moved slowly around the core. A short-circuited coil will have a current induced in it that will cause it to heat. The short-circuited coil tends to demagnetize the core of the testing magnet and to cause the current in its coil to increase. An ammeter in the magnet-coil circuit will indicate the presence of a short-circuited coil by an increased reading. Another method of detecting a short-circuited coil, and the one generally used, is to hold a piece of sheet iron over the coil under the influence of the testing magnet, shown at *A* in the picture on page 680. When the magnet is over a short-circuited coil, the current induced in the coil will set up an alternating-current field that will cause a thin piece of iron held near the stator core to vibrate.

With one phase open in a motor, the machine will not start when connected to a source of power, but will vibrate and hum as if connected single-phase. In a series-star-connected winding an open phase can be easily detected by testing between the star connction and each of the three leads. In Fig. 1, the test would be made by connecting one terminal of the test circuit, with a lamp in series, to the * connection, trying terminals *A, B,* and *C* with the other test lead. The absence of a light on any one of the terminals will indicate an open phase. In a series-delta-connected winding it is necessary to open the delta at some point, for example at *D,* Fig. 2, before the phases are tested through. When the open phase is located, the cause of the trouble may require considerable searching.

First, examine between the coils and between the coil groups for faulty connections. If the open circuit cannot be located here, a test will have to be made to try and locate the fault in one of the coils. This can be done in two ways. One method is to open the defective phase winding in the middle and test each half of the coils. When located, the defective half is divided and tested. This process of elimination is continued until the defective coil is found.

Another method of locating the defective coil is to connect one lead of the test circuit and lamp to one end of the defective phase. On the other lead put a sharp steel point and use this to pierce the insulation and make contact with the coil terminals. With the free lead make contact with the connection between the coils. It is best to first make contact with the connection between two coils in about the middle of the phase. If the lamp



Figs. 5 to 8—Simplified diagrams of three-phase motor connections

Fig. 5—Series delta. Fig. 6—Series star. Fig. 7—two-parallel delta. Fig. 8—Two-parallel star.

lights, the fault is not included in the coils between the tests leads. A connection can then be made to include about three-quarters of the coils. If the lamp does not light the fault is somewhere between the one-half and three-quarters point from the lamp. It is then a matter of gradually narrowing down the space between the points where the lamp lights and does not light, until there is only one coil remaining. On one side of this coil the lamp will light and on the other it will not. This is the faulty coil.

For example, assume that in Fig. 2 the connection

between the *A* and *C* phases was broken at *D*, the windings tested and an open found in *A* phase. One lead of the test lamp and circuit would be connected to winding lead *A*, and with the other equipped to pierce the insulation, tests would be made as previously explained. Assume that the test showed that a light could be obtained from *X*, but not at *Y*; then it would be known that the fault was in coil No. 21.

With a series-star or series-delta connection an open coil or connection causes an open phase. In many cases each phase is connected in two or more parallels, as shown diagrammatically in Figs. 7 and 8. In each of the diagrams the phases are connected in two parallels. An open as at *X* in phase *C*, Fig. 7, would leave phase *C* closed but would cut out one-half of the phase winding. A lightly loaded motor would start, with such a fault, but if loaded to near rated horsepower the phase having one parallel open would overheat.

A motor having a phase with one parallel open, if tested with ammeters as in Figs. 3 or 4, will be found to have the current out of balance in the different phases. This is the same effect as would result if a group of coils were short circuited in one phase. When tracing down faulty parallel windings it is best to open the windings at each phase-group connection and test each section separately, as explained for the series windings.

A short circuit between phases is located by opening the winding at each connection and testing with a lamp. That is, after the phase connections have been opened, connect one terminal of the test circuit to an *A* phase lead and the other test circuit lead to a *B* phase to test for a short circuit between the two. If the phases are insulated from each other the lamp will not light.

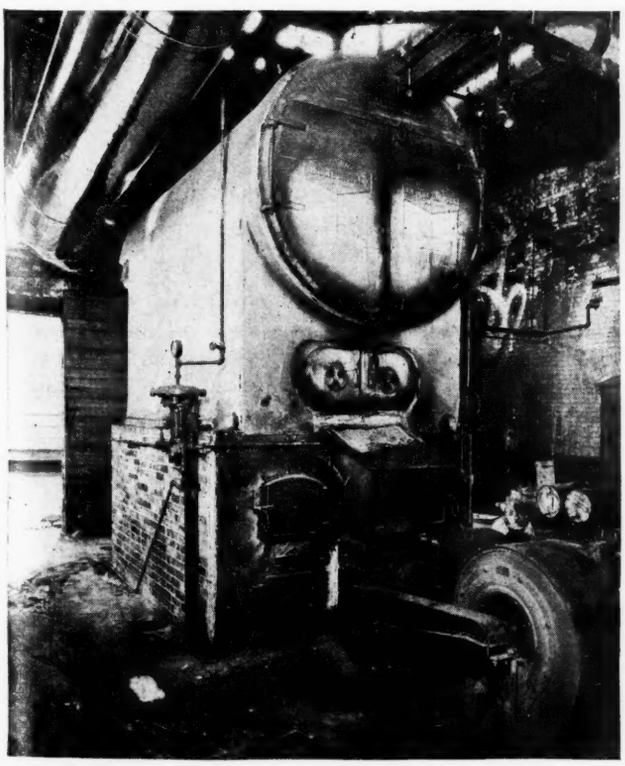
A third fault is a ground between the windings and the core. If the power system is insulated one ground in the windings will not have any effect. If the power system and the frame of the motor are grounded, a ground will affect the motor's operation, in many cases blowing the fuses. When a breakdown occurs in the windings the rush of current into the fault may be sufficient to damage the coil and immediately indicate where the fault is. If a ground cannot be located by inspection, the winding must be opened at the phase connections and each phase tested to ground.

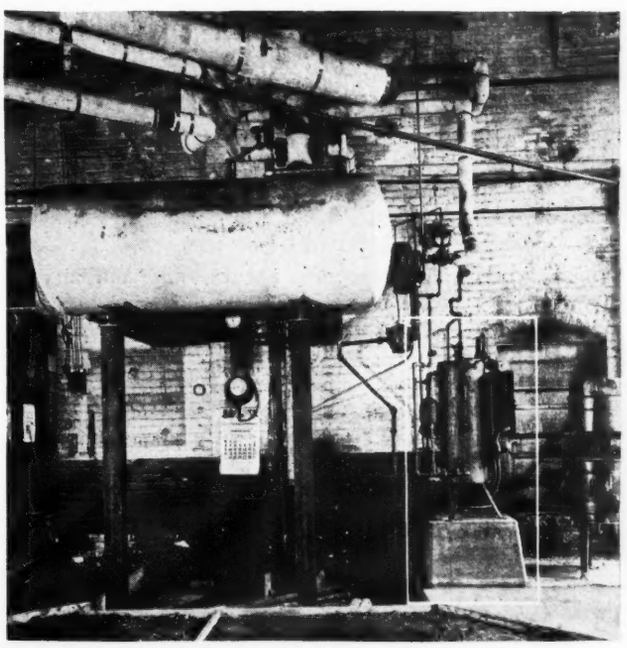
Electric Steam Generator Replaces Coal-Fired Boiler

By E. H. Hill
General Electric Company, Cleveland

A COAL-FIRED boiler used to supply steam to a Cleveland factory for building heating, for process and for hot water, has 1,350 sq.ft. of heating surface and is stoker-fired. During the winter months a large part of the boiler's capacity is required. In the summer the requirements for steam are small, but the coal-fired boiler had to be in service. On this boiler, in the summer, the operating expenses were almost as large as in the winter. This made the steam expensive. In addition, there was the usual dirt of a coal-fired boiler.

Heating boiler replaced by electric steam generator





Electric steam generator is shown in the oblong

A 15-kw. electric steam generator, 5 ft. high and 15 in. diameter, was installed in the plant. Completely automatic in operation, it is equipped with a three-heat switch for each 5 kw. of heating units, which allows the boiler's capacity to be varied by increments of 1¼ kw., from zero to 15 kw. Automatic boiler feed, automatic control and an automatic pressure switch is also provided. During May, June, July, August and September the saving over operating the coal-fired boiler is from $200 to $300 per month.

This is a good example of how a small electric steam generator may economically replace a large heating boiler during the off-peak season. Since the electric steam generator is completely automatic, no attendant is required, which was one of the large items of steam boiler expense in the summer months.

Power and Heat in Industrial Plants

POSSIBLE SAVINGS OPERATING COSTS EFFECT OF SIZE INVESTMENT

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THE study of this subject has, in the past two or three years, received an amount of attention much more commensurate with its importance than it did prior to that time. One reason is that the increase in size of industrial plants has increased the amount of money involved; another is that it is now realized that a dollar saved in producing power or heat is just as valuable as one saved by improving the process employed in the mill.

A powerful factor opposing improvement in power and heat production is quite natural and human: the operators of the plant, experienced by years in their own production, feel that few can tell them much about it—and this idea is automatically transferred to all the factors connected with production, which includes power and heat. The result is that the operators of an

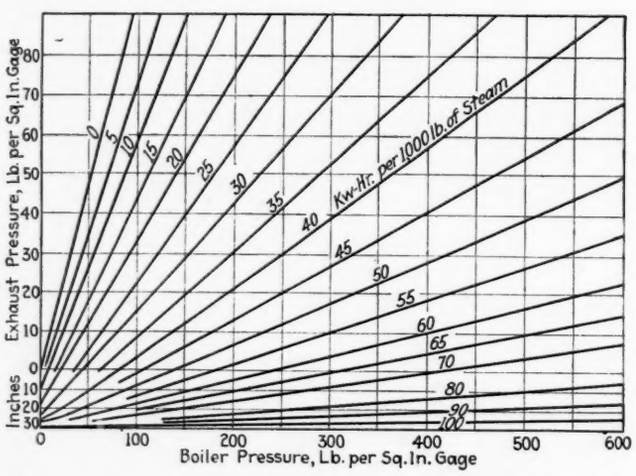


Fig. 1—Power obtainable from steam by a perfect engine

industrial plant have, in general, resisted, often strenuously, any attempts on the part of power and heat specialists to offer advice or help for the solution of their power and heat-supply problem. This resistance is gradually—very gradually—breaking down under the lead of the large industrials (steel mills, paper mills, chemical plants, and the like) which have found their power problems big enough to force the employment of specialists.

Still another factor affecting proper consideration of the subject is the accounting situation. It seems that many industrial accounting departments have lost sight of the fact that cost accounting is a tool for the use of production management, and consequently must be planned so that it will serve an engineeering purpose, not degenerating into a string of figures a month late, precise to the penny, but inaccurate.

One of the outstanding difficulties in this connection is the almost universal practice of lumping the investment

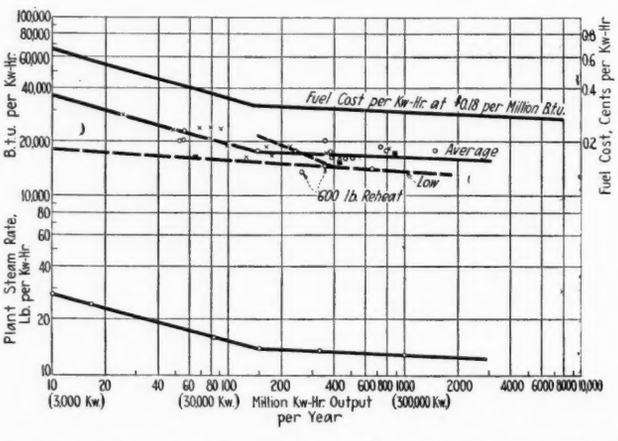


Fig. 2—Heat absorbed per net kilowatt-hour, at $0.18 per 1,000,000 B.t.u.

in power and heat-supply equipment with the main plant investment, so that power and heat costs are reported only as operating and maintenance charges. As a result, when any new power project is up for consideration it must carry both fixed and operating charges, in comparison with production charges only on the old equipment, and naturally the new project is often defeated if it is for savings alone. Only when more capacity must be supplied does the new plant get any of the "breaks."

Power and Steam Heat Relations

It is obvious that heat for process produced by the direct firing of any fuel has no effect upon the problem we are considering; but heat supplied as steam at any pressure has an enormous effect upon both power and heat cost. It is hoped, however, that by this time the older conception has died a natural death: namely, the assumption that because steam was necessary, power was obtained for nothing, or, conversely, because power was needed, steam cost nothing. Actually, the cost of

*Abstract of paper presented before the Akron, Ohio, meeting of the American Society of Mechanical Engineers, Oct. 22.

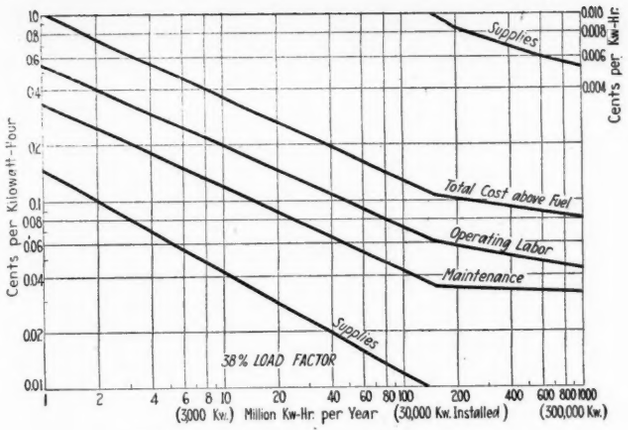


Fig. 3—Cost of power generation

power is greatly reduced and the steam cost materially reduced, and both costs are easily and rigorously calculable.

The chart shown in Fig. 1 is reproduced from the paper by Dr. Kleinschmidt, on "Balancing Heat and Power in Industrial Plants," and shows the available power developed between various initial and final pressures by an ideal engine.

Plainly, the size factor affects the cost of power, and while the comparisons about to be considered are, in general, not for straight condensing plants, we are under the necessity of getting most of the data from such sources, since they are the only ones on a reasonably comparable basis. Even in these, however, the costs vary over a wide range. Considering only plants built from 1920 to 1928, and the majority from 1923 to 1926, an analysis of cost data from 40 plants, varying from 1,000 kw. to 300,000 kw. in capacity, shows some interesting facts. Values for B.t.u. per net kilowatt-hour are the most consistent and, as shown in Fig. 2, vary from +18 per cent to —9 per cent from the average. Reducing the points from the actual capacity factors to 38 per cent capacity factor usually brings the points much nearer the average. The fuel cost can easily be plotted from this curve, the plot for coal costing $0.18 per million B.t.u. being given, and curves for coal at any other prices are simply lines parallel to the B.t.u. line.

Fig. 3 gives the average operating and maintenance costs. For the sake of clearness, the points are omitted, but in the original plot, operating labor varied +100 per cent to —30 per cent from the average, fuel cost from +100 per cent to —50 per cent, maintenance +85 per cent to —100 per cent, and supplies from +250 to —55 per cent, while the total cost above fuel varied from +120 per cent to —55 per cent. These large variations are not surprising when it is realized that the capacity factor varied from 17 per cent to 80 per cent, the average price of labor from 50 to 90c. per hour, and the design of plant to such an extent that the number of operators in some plants was twice that of others of the same size. All these variables except design of the plant could be corrected by reducing costs to a standard capacity factor and adopting a standard price for labor, but this is a task of some magnitude, and as the plots of logarithmic paper show the trend and averages much more clearly than cross-section paper, it was not thought worth while to make the corrections.

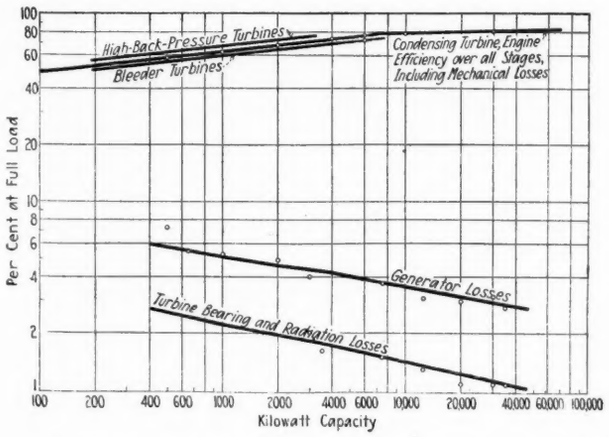

High-Back-Pressure Turbines
Bleeder Turbines
Condensing Turbine Engine Efficiency over all Stages, Including Mechanical Losses
Generator Losses
Turbine Bearing and Radiation Losses
Per Cent at Full Load
Kilowatt Capacity

Fig. 4—Turbine efficiencies at various outputs

These curves may be used with safety for any good new design, as the costs are practically all on the low side for the newest plants, and tend to decrease year by year in new designs. It is noticeable that after capacity large enough to employ 30,000 kw. units is reached, there is little further decrease in B.t.u. rate, and not much more decrease in operating cost other than fuel; maintenance, in particular, is practically unaffected beyond an output of 150,000,000 kw-hr. per year. While industrial plants (with the exception of steel mills) are not ordinarily interested in so large a plant as this, nevertheless these figures are needed to determine whether to build a new plant or buy power.

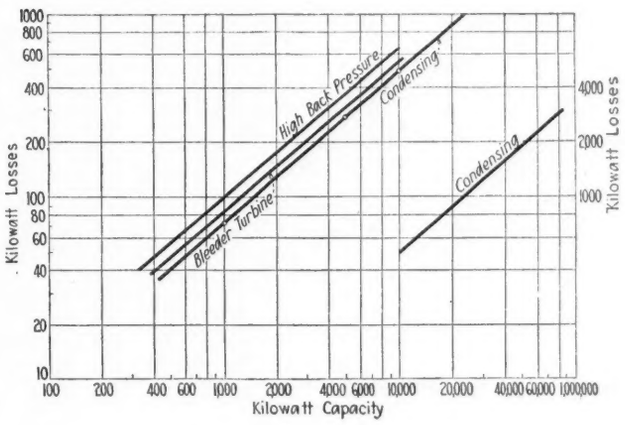


Fig. 5—Total electrical and mechanical losses

Consideration of Fig. 4 shows that the efficiency of the turbine, exclusive of external losses, such as those due to bearings, governor, oil-pump drives, generator losses, etc., decreases slowly down to the 6,000-kw. size, and only a little more rapidly below that size. It will be seen that the engine efficiency falls only from 80 per cent at 30,000 kw. capacity to 78 per cent at 6,000 kw. and 48 per cent at 100 kw. The practice of thinking of turbine efficiencies in terms of brake output or, still worse, electrical output, is undesirable as well as incorrect thermodynamically. Figuring on these bases gives erroneous steam flows and conditions. We are compelled to treat the external losses as part of the turbine output, so far as the steam is concerned. A single example will illustrate the force of this point. A 500-kw. back-pressure turbine has full-load mechanical and electrical losses amounting to 100 kw. For 400 lb. abs. (700 deg. F.) initial pressure and 160 lbs abs. back-pressure, the full-load steam would amount to 36,300 lb. per hour, the exhaust heat content would be 1,296, B.t.u. per pound and the efficiency 62 per cent. If figured on electrical

output directly, the exhaust quality would be 1,305 B.t.u. and the efficiency 51.7 per cent, the exhaust heat in this case not being so far out. But at 100-kw. load the total steam required is 14,170 lb., efficiency 48 per cent, and exhaust heat content 1,308 B.t.u. per pound. If figured on electrical output the exhaust quality would be 1,329 B.t.u. and the efficiency 25.5 per cent.

A further reason for using the method indicated is that it furnishes a reliable means of figuring the steam rates or total steam from no load to full load. The method is brief and convenient and is worked as follows: From the steam conditions selected, the adiabatic drop is taken from the Mollier diagram, the full-load wheel efficiency taken from Fig. 4, and the "indicated" steam rate then figured. Multiplying by the kilowatt load plus the kilowatt total losses from Fig. 5 gives the full-load steam. For no-load steam we merely take advantage of the fact that the no-load wheel efficiency varies only from 65 per cent of the full-load efficiency (Fig. 4) in a 500-kw. turbine to 70 per cent for a 30,000-kw. machine.

The no-load "indicated" steam rate is therefore simply the full-load indicated steam rate divided by 0.65 to 0.70, depending on the size. Multiplying this rate by the losses (which are not materially less at no load) gives the no-load total steam. The remainder of the line is straight between these two points for all bleeder turbines, and up to the opening of the secondary valve for straight condensing machines. Bleeder or back-pressure machines are generally built without secondary valves, as bypasssing stages interfere with the bleeder points.

The engine efficiency of back-pressure turbines is higher than that of straight condensing turbines, not only because the wheels are much larger, but also because the work is all done in the high-pressure and superheat region and the stages are more efficient. But the turbine mechanical losses are higher, as the machine has the weight and dimensions of the high-pressure portion of a condensing machine averaging 2.5 times the capacity.

The bleeder turbines are lower in efficiency than normal condensing turbines because the low-pressure stages are always designed for full flow to develop the output with no bleeding; but are nearly always much underloaded in actual operation, due to bleeding. The efficiency of these stages is, of course, lowered considerably, and as the high-pressure end is increased in size the no-load curves are also increased, an average of 1.5 times. Fig. 5 is convenient for taking off the losses.

Investment and Operating Costs

Plant investment costs vary not only with size but with design. It may be definitely assumed, however, that with present experience with different designs the costs may be kept on the low side. The largest variables are foundations and building structures; the former are to a great extent determined by the character of the ground, the latter partly by the character of the design and partly by the architectural features. For industrial purposes it may be taken for granted that all architectural cost effects will be low—the building will simply be a casing for equipment; the same condition is also largely true for public utility plants not located in large cities, such as New York, Chicago, and Philadelphia. Such locations always forces the building cost up, and, in general, all labor costs, both for construction and operation.

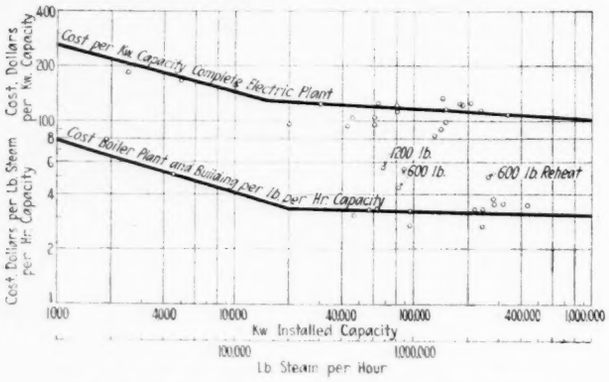

Cost per Kw. Capacity Complete Electric Plant
Cost Boiler Plant and Building per Lb. per Hr. Capacity
1200 lb.
600 lb.
600 lb. Reheat
Cost, Dollars per Kw. Capacity
Cost Dollars per Lb. Steam per Hr. Capacity
Kw. Installed Capacity
Lb. Steam per Hour

Fig. 6—Investment cost of steam plants

The variation of cost per kilowatt for complete electric plants is given in the proper curve of Fig. 6. But in an industrial plant the boiler equipment is generally much larger per kilowatt of electric capacity on account of the increased steam rate due to bleeding or back-pressure service, and in many cases because of the additional direct steam load for manufacturing service. The investment and operating costs for straight electric plants, therefore, cannot be used directly for estimating results in an industrial plant, but they do at least provide the data from which may be obtained the necessary separate information on steam-generating and power-generating sections of the industrial plant.

The data from half the plants investigated was so arranged that it was possible to separate boiler room and turbine room costs. The first information needed, that of boiler plant cost, including the necessary building, is plotted in the lower curve of Fig. 6 against steaming capacity installed. Similarly, the cost of the electric equipment, including its proportion of building, is plotted in Fig. 7. The values in Fig. 7 must be used

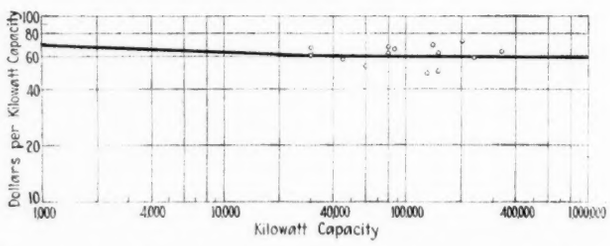


Fig. 7—Initial cost of electrical machinery and building

with caution, as the back-pressure turbines, and especially bleeder turbines of more than one point bleed are more expensive and the costs will rise to some extent.

The operating costs have similarly been split into steam generation and power generation, each including a proportionate building maintenance. They are plotted in Fig. 9. With the foregoing data we have the means of estimating with good accuracy almost any kind of industrial set-up. One other variable must be covered, namely, load factor. In all the curves given in Figs. 2, 3, 8 and 9 the costs given are for plants averaging 38 per cent capacity factor, the latter being defined as

$$\frac{\text{Net kw-hr. per year}}{\text{Installed capacity in kw.} \times 8{,}760}$$

The variations of cost with capacity factor are rather hard to pin down. Calculations on a number of plant performances for design purposes show that within reasonable accuracy the total operating costs in a given plant vary as the 0.76 power of the kilowatt-hour output.

To show how power costs can be lowered an example will be ited. A plant manufacturing artificial silk was

faced with a somewhat similar problem, but in this case the expected increase of production required steam and power in about four times the former quantities. The old plant consists of one small turbine generator and a turbine-driven refrigerating machine. The steam load is so large relative to power that even with as low a pressure as 250 lb. (550 deg. F.) there will be live steam to the extent of 30,000 lb. per hour needed in winter, but an even balance in summer. The new plant would be made up of three 1,500-kw. turbines bleeding a small amount at 140 lb. for heaters and evaporators (30 per cent make-up exhausting to the 15-lb. system), 15 lb. back pressure, and three 6,500-sq.ft. boilers. The steam demand 24 hr. a day 7 days a week for 7 months is 131,000 lb. per hour and 124,500 for 5 months, all the 15-lb. steam from the evaporators and turbines being used to heat 2,500 g.p.m. of hot water and for other mill process. The heat balance is arranged so that by shifting the load between the heater condenser on the

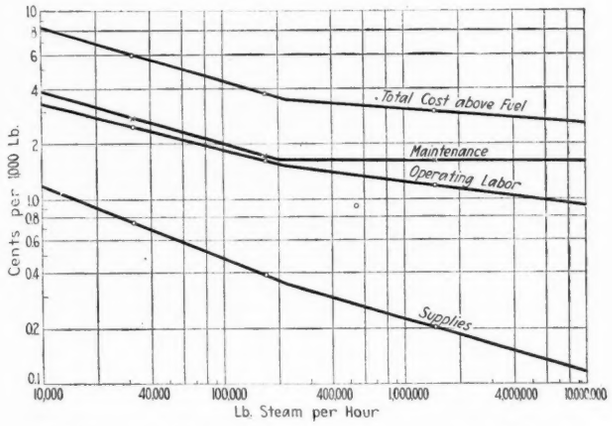


Fig. 8—Cost of steam production, including building maintenance

turbine exhaust and the mill heaters, no steam is wasted, but in winter some must be put through a reducing valve to the 15-lb. system. The costs are 28.95c. per 1,000 lb. low-pressure steam operation ($4.55, 13,000 B.t.u. coal) and 7.15c. fixed charges, or a total of 36.10c.; and power, 2.26 mills operation and 1.37 mills fixed charges, or a total of 3.63 mills, far below the cost of purchased power.

Another plan of operation has been proposed several times in the last few years and promises much; although so far it has been put into practice in only one plant; that is, for the public utility to build a 1,200-lb. station at the industrial, serving steam at anything up, to, say, 250 lb. gage and such power as the industrial requires, and taking up whatever of the remaining power it requires for its own service. This power has the advantage of being available at peak, as distinguished from "dump" power, and is therefore much more valuable to the power company.

There are four ways in which the industrial can plan its power and steam supply:

1. Complete plant, with suitable reserve, no utility connection.
2. Normal-load plant, no reserve, public utility for excess power and reserve.
3. Public utility high-pressure plant, supplying steam and power to the industrial and furnishing excess power to its own lines.
4. Purchase all power, and operate a low-pressure industrial steam plant.

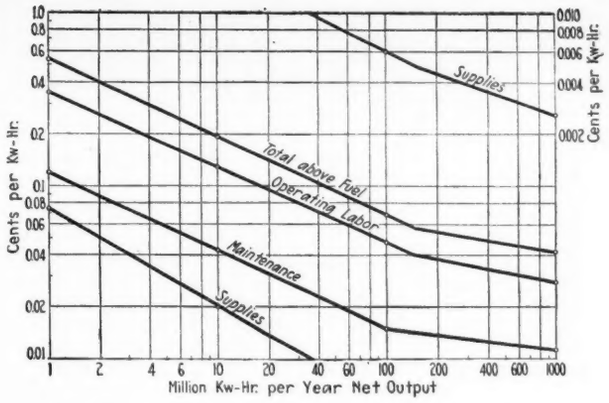


Fig. 9—Production cost of power, including building upkeep

The first two methods may be desirable for plants having relatively low power and high steam requirements, and the choice between them must be made for each individual case. The third scheme will likely be desirable for large plants, or a group of plants close together, aggregating a large demand. The fourth scheme will generally apply only to the small plant with low steam demand relative to power.

It must be clear that there is no general solution for the problem of heat and power supply for industrials, as the permutations are endless. Every case must be solved for itself. The variables are: price of coal and labor, relative power to steam, load factor, investment and operating cost as affected by size and rate of growth.

Journalistic Engineering

WE LEARNED some really startling things from a recent edition of the Yonkers (N. Y.) *Statesman*, concerning two of the "most modern engineering plants in the world," that were lately placed in operation at Yonkers. We quote from this report the following:

"Burning pulverized coal, the unit carries more than 1,200 lb. of steam. The boiler plate itself is 2 in. thick and is securely held together by large bolts every 3 in. over its entire surface. [Perhaps Yonkers has a special building code that allows for this construction.]

"The firebox, which keeps a large corps of firemen busy during the plant operation, is about two city stories deep and burns hundreds of tons of coal during the course of a month.

"The installation at Saw Mill River Road has made it possible to cut down on the number of men employed in this particular branch of work. Whereas 26 engineers were formerly needed, only 8 are necessary to operate the new plant. Formerly 46 stokers were on the job; now there are only 20, and their chief duty is watching the giant water tenders. [The stokers rather than the water tenders normally require watching, but then every plant doesn't have giant water tenders.]

"Under the new system 250 lb. of pressure can be carried from the factory on Lake Avenue to the works on Ashburton Avenue in huge turbines, with the loss of only 3 lb. pressure." [Every engineer knows that a turbine has wheels, but this is the first time we know of its being used as a wagon.]

It would seem that if this newspaper intends to discuss the engineering of power plants, it should secure the services of a technical editor to read over the copy.

Right Out of the Plant

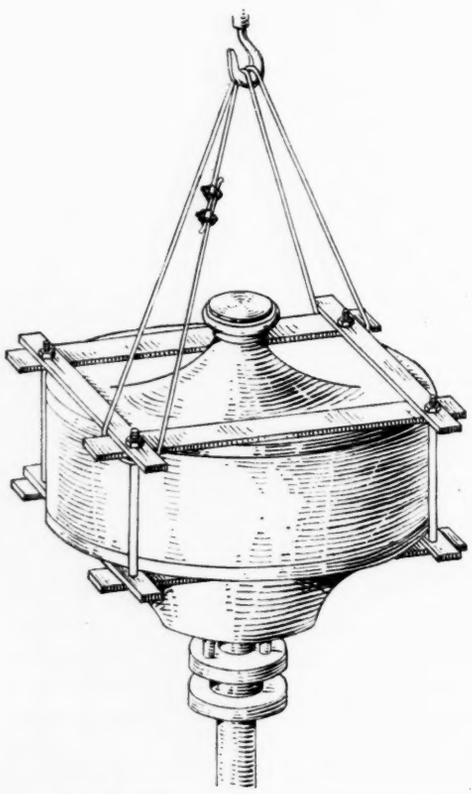
Pointers on Dismantling Turbine Governors

IT IS frequently necessary to look over the thrust bearing and governor-drive gear on a steam turbine more often than to examine the rotor blading and shaft bearings. To raise the governor out completely, it is necessary to remove the holding-down bolts and disconnect the pilot valve (after tramming or marking the setting) and governor arm at the steam valve and the governor.

The Jahns type of governor, or similar types, is generally topheavy, and has to be raised from 6 to 7 ft. to clear the pedestal. Tying ropes around the governor to raise it is not only a hit-or-miss method but is decidedly dangerous. The rope might slip and drop the governor, which might mean serious damage to it.

It occurred to me that the method we use in our plant might be helpful to *Power's* readers. There is usually enough scrap iron around a plant to make a permanent lifting device, as illustrated, so that it should involve no great expense.

In four pieces of iron about 24 in. long, 2 in. wide and $\frac{1}{2}$ in. thick and four pieces the same length and



Lifting gear for turbine governor

width about $\frac{3}{8}$ thick drill $\frac{5}{8}$-in. holes at each end and the same distance center to center for the holding bolts. The bolts should be long enough to go through the four iron straps when in place on the governor.

When the lifter is in position place a sling or rope around the corner of it, making one knot and leaving the sling free to slip around the hook on the hoist. One man should guide the governor spindle until it is free from the turbine, and at the same time see that the bearings are not damaged. Make a mark on the governor pedestal, noting the position of the slot at the end of the governor spindle. This will insure accuracy of position in relation to the gears and pump when the governor is again lowered into place.

PHILIP T. HYNES.

New Haven, Conn.

What Causes Air-Receiver Explosions?

THE several letters which have appeared in *Power* on the subject of "What Causes Air-Receiver Explosions" have been of much interest to me. Various reasons have been advanced for explosions of this kind, but in my opinion these could be reduced to three principal causes. First, defective compressor operation, which leads to an excessive pressure, or temperature, of the air; second, weakening of the compressor system and receiver through corrosion; third, explosions in the system due to combustible vapors in the compressed air.

Accidents due to the first-named cause are rare, the chief causes being leaky valves or piston rings, improper cooling of the air between stages, or some misadjustment of the piston top clearance.

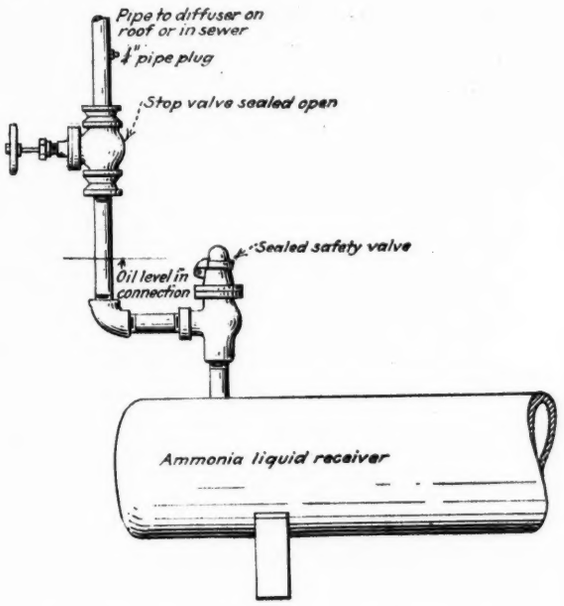
Corrosion of the coils and receiver are more frequent, the causes being acidity brought about by an excessive quantity or an inferior grade of oil, which decomposes under the high pressure and temperature in the system. This is assisted by moisture in the air, failures due to corrosion occurring most frequently in humid atmospheres. Explosions in the receiver system due to inflammable oily vapors in the air are frequent. Normally the temperature in the system should not be sufficient to ignite this vapor, but ignition may occur through a sudden rise in the temperature and pressure of the air, through some fault on the compressor or through the lowering of the temperature of ignition by decomposition, it having been proved that gases that can be ignited at comparatively low temperatures can be generated through the decomposition of lubricating oil. Another theory, advanced by a French professor, is that the air rushing through the pipe lines at high pressure and containing small particles of moisture leads to the generation of static electricity, and this causes sparks and ignition.

To reduce the risk of these accidents the compressor should be lubricated sparingly with a high-grade compressor oil, straight mineral oils being most successful. In some cases oil lubrication is dispensed with except for starting and stopping, a mixture of soft soap and water being used for lubricating when running, oil lubrication being reverted to one hour before stopping to remove any water from the system. Soft soap is best, using just enough to make the water soapy. This solution can be fed through the standard oil lubricator. The system should be kept well-drained of any collected water, as this assists corrosion by its action on the oil.

Brentford, England. W. E. WARNER.

Safeguarding Pressure-Relief Valve Against Rust and Corrosion

THE formation of rust inside of a safety valve exposed to the air is inevitable. To guard against this, the method of connecting up the safety-valve as shown in the sketch was developed. Before the stop valve is built into the line, ice-machine oil is poured into the pipe nipple until the level of the oil is high enough to submerge the interior parts of the safety valve above its seat. Air and moisture will thus be excluded and the valve will remain in first-class condition. A ¼-in. plug is inserted in the pipe line to the diffuser. Should there be any suspicion that the safety valve is leaking a check can promptly be made by removing the pipe plug and determining if there is any ammonia odor in the pipe.


Pipe to diffuser on roof or in sewer
¼" pipe plug
Stop valve sealed open
Sealed safety valve
Oil level in connection
Ammonia liquid receiver

Working parts of valve are submerged in oil

Milwaukee, Wis. R. S. WHEATON.

Cause of Water-Hammer in Bent-Tube Boiler

A RATHER interesting case of water-hammer developed in one of our 1,500 sq.ft. bent-tube boilers during the past summer. The feed water was delivered through the top of the drum into a trough located about the middle of the rear drum. The feed line ended in a T having a short nipple in each end to deliver the water to each end of the trough. These nipples were below the top of the trough, and were therefore always covered with water. One day a bad case of water-hammer developed in the feed line at the boiler. The check valve would have spells of clacking and snapping irregularly.

It was noticed that whenever the fire was hot the water level in the glass would rise and the snapping would begin, but when the fire burned low the water level would drop and the water-hammer would cease. It was found that when the water dropped below one-third of the glass the water-hammer would occur. Since it was necessary to keep the boiler in operation for at least a month before it could be shut down and the trouble corrected, the water level was maintained around one-half glass.

On shutting down the boiler it was found that the trough had fallen down, leaving the nipples open to the steam space, except when the water was above one-third of the glass. As the feed temperature averaged around 150 deg. and the steam at 125 lb. was 353 deg., steam was being condensed at the check valve, causing the water-hammer, when the nipples were exposed in the steam space. When the nipples were under the water the steam could not reach the check valve and it would work smoothly. When the fire was hot the front bank of tubes steamed violently and tended to draw the water to the middle and front drums. This caused the nipples to be submerged and exposed to the steam intermittently by the heaving of the water surface, and resulted in the water-hammer. CHARLES F. FORBES.

Medical Lake, Wash.

Installation of Engines Cuts Down Coal Bill

IN reply to A. H. Robinson's comments in the Aug. 27 number of *Power* on my article entitled "Installation of Engines Cuts Down Coal Bill," which appeared July 2, I am glad to present additional information that I have. In the tabulation of operating costs, the "Total Direct Operating Expense" included only items directly chargeable to operation, such as labor, oil, and miscellaneous supplies.

There was no increase in the operating force after the engines were installed, since the same crew is handling the generating equipment in 1929 as was required in 1928, when operating the heating plant only.

As stated in my original article, the power house, which was built in 1920, was designed at that time for the future installation of engines and generators, and the space provided for this purpose was not used until the installation of generating equipment, in 1928. Therefore, in making this comparison, no charge was made for the space used.

On a conservative basis, this plant will make a gross saving of at least $20,000 a year. As a matter of fact, during the first seven months' operation, a total gross saving of $9,569 has been effected over the same months in 1928, in spite of the fact that there was an increase of 160,240 kw.-hr. in the electrical energy consumed during these same months of 1929.

Deducting 2 per cent ($1,700) for insurance and taxes, leaves a net saving of $18,300 a year. If we apply this saving against the original cost of $85,000 after deducting interest at the rate of 6 per cent per year on the constantly diminishing investment, the entire cost will be wiped out in six years.

In other words, we have depreciated the plant in six years, and during the remainder of its useful life—of, say, 14 years—it will continue to earn at the rate of $18,300 per year. If this be compounded annually at 6 per cent, the total saving during the useful life of the plant will be $400,000 in addition to having paid for itself and the interest charges.

The saving in coal consumption in 1929, when operating their own plant, compared with 1928, when power was purchased, would seem to bear out the contention of some engineers that exhaust steam is a more effective heating medium than live steam at the same pressure.

This is explained by some authorities as being due to the pulsations in the exhaust from the reciprocating engines.

With regard to the point made by Mr. Robinson that I have not taken into consideration whether the maximum outdoor temperature lasted for ten minutes or ten days, the meteorological data given were taken from the official United States Weather Bureau records. The temperatures given were the average daily maximum and the average daily minimum and also the average temperature for the entire month. If the maximum temperature had lasted for ten days, as Mr. Robinson suggests, this would certainly be reflected in the monthly average temperature. The average outdoor temperature for any month is therefore a true index of the amount of artificial heat required.

C. J. SNOW.

St. Paul, Minn.

Chimney Gases Nourish Hot-House Plants

QUOTING from an article in the Aug. 20 number of *Power*, entitled "Effective Stack-Gas Purification," "the perfect chimney, from which nothing could emerge but clean, pure and harmless gases, is an ideal capable of realization if the smoke nuisance be given the attention it deserves." This expresses an ideal condition that has already been obtained in at least three instances.

The success of operating large greenhouses in connection with central power stations, utilizing the waste gases for the growing of plants, as employed at the Wiesmoor Station of the Nordwestdeutsche, Kraftwerke A.-G., and the Bleicherode Station of the Uberlandzentrale Sudharz, G.M.b.H., has encouraged the building of larger greenhouses, which take stack gases from the pulverized-fuel-fired boilers at the Klingenberg power station.

The greenhouses are arranged for the growing of certain vegetables and also have a large flower section. The total area under cultivation is 108,000 sq.ft., while available reserve space will permit 54,000 sq.ft. additional area. Steam is bled from the turbines for heating both the soil and the atmosphere in the house, which insures a favorable growing temperature during the winter months. Also, electric light is employed, which has a further beneficial effect on plants.

The purified waste gases, with sulphurous combinations removed, are used as carbonic acid fertilizer. These gases, after having served as heat-carrying mediums in boiler, economizer and air heaters, are drawn from the uptake through a purifying plant by a fan which forces them 1,150 ft. through an underground pipe line to the greenhouses, where they are uniformly distributed. The gases used represent a small fraction of the total expelled from the powdered-fuel-fired boilers. The installations have been in service since March, and were visited by the writer during May. The growth of the gassed plants was greatly superior to that in ungassed greenhouses.

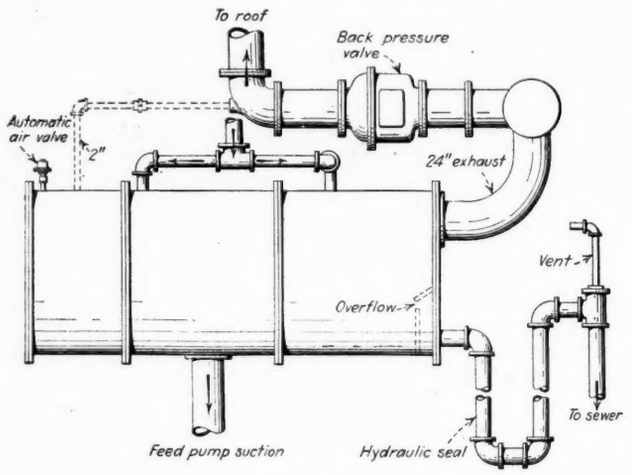
Although much skepticism exists among power plant engineers as to the possibility of cleaning stack gases, a little investigation would disclose that the apparatus for purifying gases is simple, dependable and comparatively inexpensive, and the process requires little or no attention. Such an installation would not increase the over-all initial cost or operating expense of the central power station, particularly if all the chimney gases were purified before being expelled to the atmosphere.

New York City. J. GOULD COUTANT.

How the Operation of an Open Heater Was Improved

THE illustration shows a feed-water heater of the open type. When first put into operation the temperature of the feed water never went over 195 deg., with exhaust steam escaping through the back-pressure valve. The recording gage on the exhaust line showed that the back pressure varied from 4 to 7 lb., with little variation on the load on the machines exhausting into the line.

As will be seen from the sketch, the exhaust steam enters the heater at one end through a 24-in. line. There are three ¾-in. automatic air valves at the other end, to



General arrangement of heater and connections

take care of the air entering the heater with the steam. A 2-in. pipe was connected, as shown by the dotted lines, from the top of the heater to the exhaust pipe going to the roof, and immediately the temperature of the feed water rose to 214 deg. and the back pressure dropped to 3 lb., with no steam going to waste at the exhaust head.

The variations in the back pressure were caused by the air valves being too small, allowing the heater to get airbound until the pressure built up enough to force the air out. Then as the steam passed through the heater it condensed and the back pressure dropped. The heater was piped according to specifications, and was operated in the manner mentioned for several months before the trouble was rectified.

THOMAS SHEEHAN.

New York City.

Smoky Exhaust From Oil Engine

I NOTE in *Power* for Oct. 8 that a reader wanted to know what causes smoky exhaust in an oil engine plant.

In our plant one unit developed a smoky exhaust after two years' operation. We had not changed fuel oil, and the rings were found to be in good shape, so the cause was traced to the spray nozzles, which are made up of a number of fine holes. These holes had became enlarged and were not breaking up the oil.

If the engine mentioned in the question is equipped with nozzles of this type, it will pay "J.C." to look them over. They may be the cause of the smoky exhaust.

Cedar Rapids, Iowa. WILLIAM W. DINGWALL.

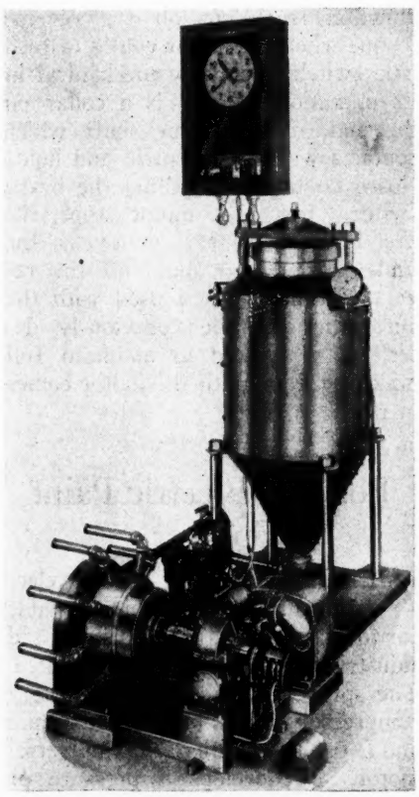
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

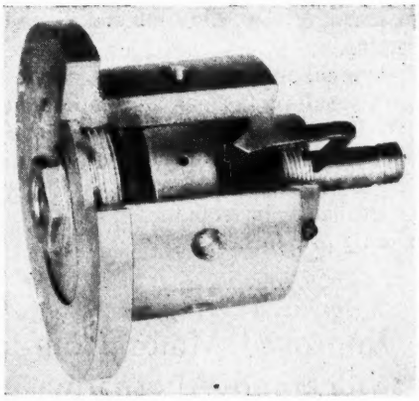
Completely Automatic Lubricating System

IN THE March 6, 1928, number of *Power* the pneumatic centralized greasing station put out by the Keystone Lubricating Company, Philadelphia, Pa., was illustrated and described. This unit was designed for feeding grease through one or more header lines with connecting leads to practically any number of bearings and at varying distances from the unit up to 300 ft. This system has recently been extended to include a motor-driven rotary grease distributor and an electric clock to control the time of distribution.

The new system, which is designated Pneuma-Lectric, provides complete automatic lubrication with practically no attention except occasional filling of the grease tank. It is readily adaptable to practically all types of machines, and the intermittent feed is adjustable to the requirements of the unit being served. It is possible to vary the time at which the grease is fed from once in five minutes to once in 24 hours.



Complete lubricating unit with motor driven rotary distributor and timing clock



Cut away view of rotary distributor

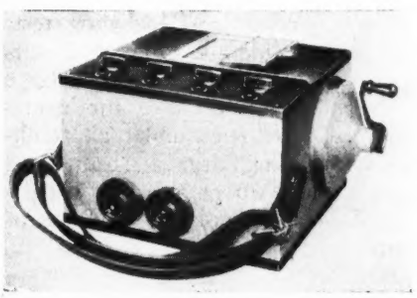
As mentioned in the previous description, the machine consists of a conical-base grease tank and an automatically controlled motor-driven air compressor mounted on a common base. The compressor is regulated to maintain the pressure in the tank above the grease between the limits of 170 and 210 lb. The discharge is from the bottom of the conical base to the rotary distributor, which is driven by a motor through a worm-gear-reduction unit. Operation of the motor driving the distributor is controlled by the electric clock, which may be set to any predetermined period of time. When the time period has been reached the clock actuates a relay, which, in turn, applies current to the motor. The motor operates the distributor, and a charge of grease is supplied to each bearing consecutively, the motor continuing to run for about 12 seconds, until the clock breaks the contact.

A drum-control switch is mounted on the end of the distributor shaft to prevent the distributor stopping on an open port. This keeps the distributor in motion until the safety zone is reached, when a shunt electric brake stops the motor.

The rotary distributor is made in two sizes, No. 2 with a 2-in. rotor and No. 8 with an 8-in. diameter rotor. (Intermediate sizes are made to meet certain requirements.) The No. 2 size is made with 8 outlets and 24 outlets, ¼-in. pipe tap. In the No. 8 size there are 8 outlets, 1-in. pipe tap. The rotor of the distributor is made hollow and with one master port for each line of 8 outlets. Grease enters the hollow rotor and as the master port registers with an outlet port the grease moves forward into the line leading to a bearing. Pilot lamps are incorporated in the circuit to show when the unit is in operation. They may be located at any convenient position. Although the various parts of the units are shown grouped in the illustration, their location can be varied to best meet the needs of the installation.

New Megger Instrument

FOR measuring resistance from 0.01 ohm. up to 100 megohms (100,000,000 ohm.) a new "megger" instrument, called the "bridge-meg" resistance tester, is being offered by James G. Biddle, 1211 Arch Street, Philadelphia, Pa. This instrument combines in one unit facilities for making Wheatstone bridge measurements of conductor resistance at 250 volts, and also megger tests of insulation resistance at 500 volts. It weighs only 12¾ lb., and measures 7 x 8¾ x 12 in. It includes the necessary dial resistances for bridge tests, a direct-reading ohmmeter for megger tests, and a 500-volt direct-current constant-pressure hand generator for current supply.



"Bridge-meg" resistance tester

The range of measurement covered by the "bridge" is from 0.01 ohm. up to 999,900 ohm., and the meg range is from 10,000 ohm. up to 100 megohms. The meg portion of the set is similar to the meg and super-

meg insulation testers offered by this company, allowing direct reading by means of a pointer over a scale when connections are made and the hand crank is turned. The "bridge" arrangement has four dials of nine coils each in the resistance arm, giving a total of 9,999 ohm. A five-position ratio dial gives the added breadth of range down to 0.01 ohm and up to 999,900 ohm. As a bridge it is operated in the same way as an ordinary Wheatstone bridge set except that, instead of employing a battery, current at 250 volts is supplied by the hand generator, and the ohmmeter is used as a galvanometer for balancing.

The change from bridge to meg, and vice versa, is made by merely turning a two-position dial. The bridge rheostat dial positions are shown by numbers on disks which appear through small windows next to each dial. The case is of cast aluminum, with bakelite top and base. A metal lid covers the meg scale and a leather strap is provided for carrying.

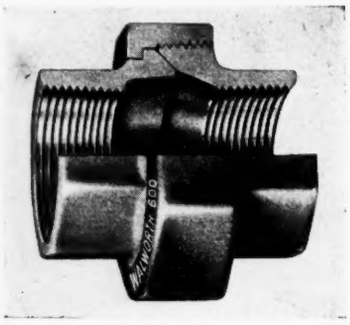
An important feature of the hand generator is a slip-clutch arrangement by which a constant potential is delivered when the hand crank is turned at or above its rated speed of about 160 r.p.m. This makes it possible to use the instrument as a bridge under all conditions, including tests where a considerable amount of self-induction is present, such as in large coils, and also as a meg for insulation-resistance tests under all conditions, including large apparatus and long cables, where there is usually a considerable amount of electrostatic capacity.

Forged-Steel Union for High Pressures

A FORGED-STEEL union designed especially for high pressures and temperatures has recently been introduced by the Walworth Company, Boston, Mass.

The three parts of the union are forged from high-grade steel. A tight-fitting joint is attained by pressure of the forged-steel thread end upon the forged-steel bottom on a ball-joint seat. An extra long thread connection is provided between the thread end and ring. It is pointed out by the manufacturer that the long thread chambers for pipe connections eliminate, to a great extent, danger of damage from vibration shocks and strains.

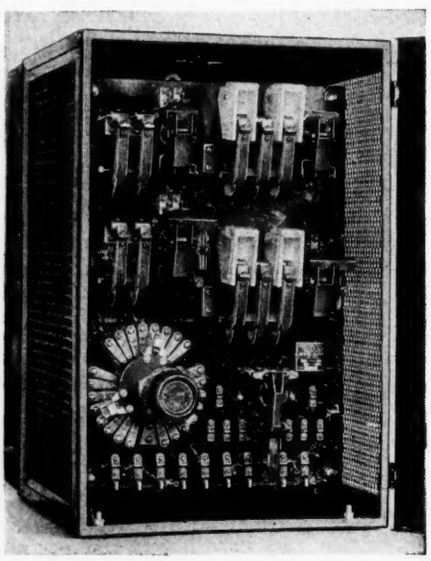
The union is suitable for service with steam or hot oils and vapors, at 600 lb. pressure and 750 deg. total temperature, and, on cold water, oil or gas at pressures up to 2,000 lb. It is available in standard pipe sizes from $\frac{1}{8}$ to 2 inches.



Cut-away view of union

Improved Motor Controller and Alternating-Current Brake Switch

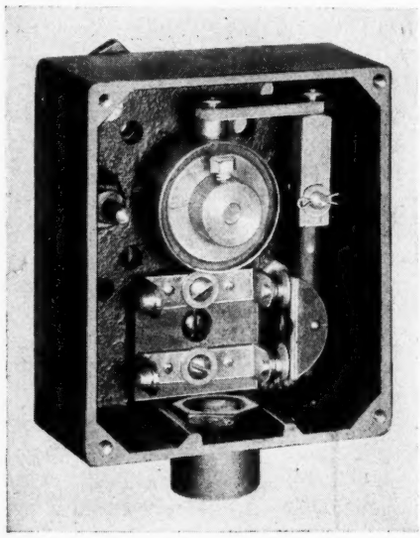
AN improved pre-set speed controller for application to alternating-current slip-ring motors and a new alternating-current brake switch are recent additions to the line of controllers put out by the Monitor Controller Company, Baltimore, Md.



Improved pre-set speed controller

The principal improvement to the controller, which is of the push-button reversing type, providing reverse-torque braking, is the adoption of a side-frame construction on which the panel and resistors are mounted independently, instead of the resistors being mounted on the panel, as in previous types. This gives a rigid structure and a complete assembly that is readily removed from the cabinet as a unit for inspection or repair. The controller is designed to perform the following functions: start, jog forward, jog reverse, run at slow speed, run at pre-set speed and brake stop. These functions are co-ordinated and under control from an operator's station equipped with only two buttons and two levers.

The brake switch previously referred to is arranged for mounting on the end bell of the motor and for operation from the motor shaft. Its function is to cut off the reverse torque when the motor comes to rest. The switch is entirely mechanical in its operation. There is a collar on the end of the motor shaft which contacts with a concentric and holds closed contacts controlling the brake switch. Once the motor stops, the first motion to reverse opens the brake switch and shuts off the reverse torque. When used with the automatic controller previously described, it is said to maintain full braking torque until the motor comes to rest.

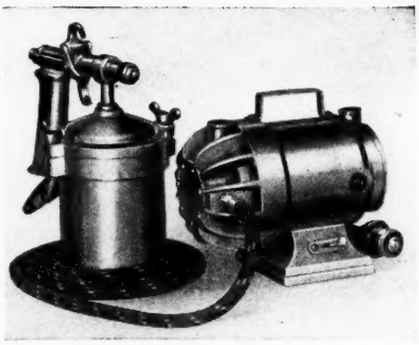


Brake switch is mounted at end of motor shaft

Portable Electric Paint Sprayer

A LIGHT-WEIGHT portable electric paint spray machine suitable for touch-up work, light finishing and industrial painting work, is illustrated. The sprayer, which is of the rotary compressor type, is built of aluminum and is equipped with a $\frac{1}{3}$-hp. universal motor. It develops a pressure of 35 lb. The compressor unit weighs 7 pounds.

The spray gun is equipped with



Motor-driven compressor and spray gun

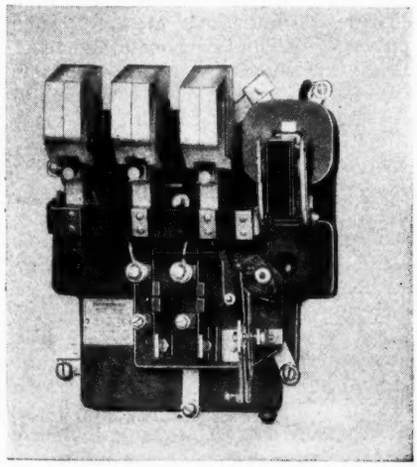
two tips, one slotted for fan spray, and the other for narrow spray, covering an area of 2 in. to 14 in. in width. A handy adjusting screw controls the amount of paint used. The gun weighs 2 lb. The machine is furnished equipped with a quart container, two tips, 20 ft. of reinforced rubber-covered cord and 8 ft. of rubber web-covered hose. It is put out by the Breuer Electric Manufacturing Company, 852 Blackhawk St., Chicago, Ill.

Line Starter Without a Cabinet

THERE are certain applications in which it is desirable to use a motor starter without a cabinet. For such services, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has introduced the improved unit illustrated.

Like other line starters put out by the company, it is equipped with the Deion arc quencher and the thermal overload relay. The arc quencher gives protection from flashovers under severe operating conditions and also increases the life of the contacts. Because the arc is completely restricted within the quencher, the overall size of the starter has been decreased somewhat.

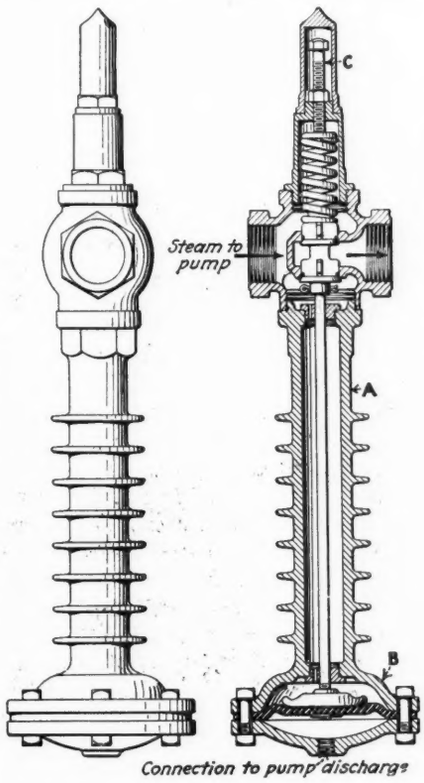
An important feature is the combined hand and automatic reset thermal overload relay. The automatic reset obviates the necessity of the operator going to the starter to put the motor back on the line after an overload. The starters are available in three sizes covering a range up to 50 horsepower.



Complete motor starter without cabinet

Packless-Type Excess Pressure Pump Regulator

ABSENCE of packing, giving free movement to all working parts without tendency to stick or bind, is an important feature of the excess-pressure pump regulator, illustrated, put out by the Julian D'Este Company, Cambridge and Spice Sts., Boston, Mass.



Assembly and sectional view of regulator

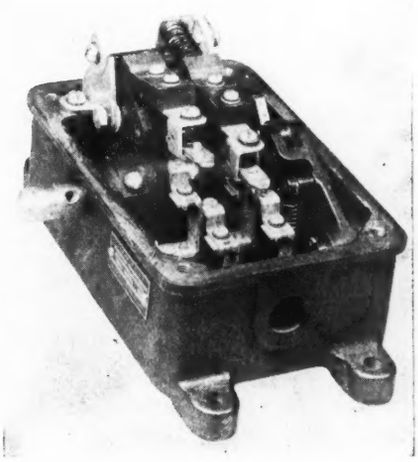
The regulator is designed to control a reciprocating or turbine-driven steam pump so that a constant fixed excess pressure above the boiler pressure is maintained in the boiler-feed line. The regulator is installed in the steam-supply line to the pump, with the diaphragm chamber downward, as shown. This chamber is connected by a small control line to the discharge of the pump. In this way the amount of steam passed through the valve to the pump is controlled directly by the pressure maintained on the feed line.

The valve bonnet *A*, which extends from the valve body to the diaphragm chamber *B*, is made long and ribbed to insure condensation at reduced temperature, being maintained above the diaphragm at all times when the valve is used with superheated steam.

An adjusting screw *C* provides a ready means of varying the excess pressure to any value. The regulator is made in sizes of $\frac{1}{2}$ to 3 in., inclusive.

New Limit Switch for Industrial Control Applications

A NEW cam-operated limit switch for industrial control applications is announced by the General Electric Company, Schenectady, N. Y. The new switch supersedes the various older types made by the company. Electrically, it is a two-circuit switch that can be made either normally open or normally closed, or one circuit open and one closed. It is a snap-action, cam-operated device and can be obtained with either spring or star-wheel return, with any one of four operating levers: a roller lever with a 1- or 3-inch roller, a forked lever or a straight lever. The contact tips are interchangeable with those of standard cam-operated master and geared limit switches made by the company



Limit switch with cover removed

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

PROTECTION OF POLYPHASE MOTORS AGAINST REVERSE-PHASE OPERATION—*Section 1003-k of the 1928 National Code states that polyphase alternating-current motors operating elevators or cranes shall be protected by approved automatic circuit breaker (or reverse-phase relays) operative in the event of a phase reversal that would cause reverse motor rotation, or in event of the motor being connected to the line single-phase. I have heard considerable discussion on this section, as to whether it means that all polyphase elevator motors shall be so protected. In some cases reverse-phase relays are installed on elevator motors, and in others they are not. Just how is this clause to be interpreted?* W.T.D.

The general use of reverse-phase relays on elevators has not become a national standard. Some of the states require them and others do not. Quite a number of elevator accidents have occurred through reverse phase. These could have been prevented by a properly installed and maintained reverse-phase relay. If you wish to insure against such accidents happening to elevators, install a reverse-phase relay.

If you will refer to page 179 of the code, section 3103-c, you will find that reverse-phase relays are specifically recommended. The paragraph reads: "Each electric elevator operated by a polyphase alternating-current motor shall be provided with a device which will prevent starting the motor if: (1) the phase rotation is in the wrong direction, or (2) there is a failure in any phase."

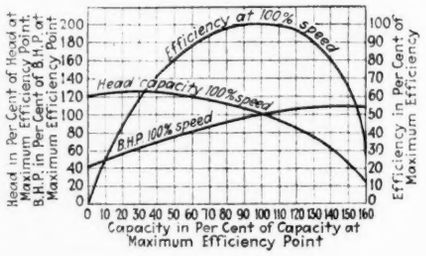
Sections 1003-k and 3103-c of the 1928 National Electrical Code, while there may be a variation in their statement of the requirements, do not conflict. Section 1003-k specifies protection against reverse-phasing and single-phasing by the use of circuit breakers or reverse-phase relays. Section 3103-c also requires protection against reverse-phasing and single-phasing, but does not specify the means. Section 3103-c is a little more liberal, in that it is specifically provided that this protection shall be such that it "will prevent starting the motor." Section 1003-k may be construed to require both forms of protection during the running period.

In drawing up Section 3103-c, two conditions were assumed. First, that it would be very improbable that the lines supplying an elevator motor could be reversed during the operation of the motor, and that any reversals likely to occur would take place when the motor was at rest. Secondly, that with the short periods of operation peculiar to elevator work, single-phasing would not continue long enough to cause harm.

CENTRIFUGAL PUMP AS A BOOSTER—*We have a 10-in. 1,800-r.p.m. centrifugal pump device connected to a synchronous motor which operates against a head of 85 lb. We wish to connect this so that a second pump will deliver water to it at 60 lb., the final head to remain at 85 lb. Can this be done?* C. F. N.

Much depends upon the characteristics of the motor-driven pump, but, broadly speaking, it should be possible to make the arrangement without unduly overloading the motor. Assuming that the pump has a characteristic curve similar to that shown in the illustration, it can be seen that at the normal head, which is 85 lb. in this case, gives a 100 per cent capacity, of, say, 2,000 gal. per minute. If the suction is put under a 60-lb. head the pump's net head is 25 lb., or approximately 30 per cent of its normal head. Inspection of the illustration shows that at this percentage of rated head the pump will have a capacity of 155 per cent normal, or 3,100 gal. per minute. This is ignoring the friction loss in the pipe lines.

The increased discharge will cause the friction loss to vary approximately as the square of the velocity, or the frictional loss with the contemplated arrangement would be about 240 per cent of that with the present connection. Just what the friction loss totals is not given. To show its influence let us assume that,


Efficiency at 100% speed
Head Capacity 100% speed
B.H.P. 100% speed
Head in Per Cent of Head at Maximum Efficiency Point
B.H.P. in Per Cent of B.H.P. at Maximum Efficiency Point
Efficiency in Per Cent of Maximum Efficiency
Capacity in Per Cent of Capacity at Maximum Efficiency Point

Characteristic curves of a centrifugal pump

of the 85 lb. head pressure, at present 30 lb. is due to friction. Then, with the increased flow, the friction loss is $30 \times 2.4 = 72$ lb., and the pressure at the end of the pipe line instead of being $85 - 30 = 45$ lb., will be $85 - 71 = 13$ pounds.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

I HAVE frequently read that the plant engineer should determine the quantity of carbonates, bicarbonates and hydrates that make up the total alkalinity of the feed and boiler water. How can I use this information to guide our feed-water treatment?

G.S.B.

THE alkalinity of a water represents its content of carbonate, bicarbonate, borate, silicate, phosphate and hydroxide, or such of these as may be present. In addition it may contain sulphates, chlorides and nitrates. Obviously, bicarbonates and hydroxides cannot exist in the same solution, and a water containing sodium or potassium carbonate is not likely to contain calcium, magnesium or iron as bicarbonate, because reactions such as the following would occur:

$$Ca(HCO_3)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaHCO_3.$$

Bicarbonates of the metals which constitute temporary hardness are converted into the normal carbonates by boiling the water,

$$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2.$$

Because of the limited solubility of the carbonates, a precipitate is thus formed and the hardness of the water is reduced to this extent.

The permanent hardness of a water consists of its non-carbonate hardness plus the hardness due to a saturated solution of calcium carbonate and magnesium carbonate. The non-carbonate hardness may consist of sulphates, chlorides and nitrates of calcium and magnesium, etc.

The non-carbonate hardness is usually removed by treatment of the feed water with soda ash, thus converting the non-carbonates into insoluble carbonates. Lime is generally used to precipitate any bicarbonates, carbonates, or hydrates which may be present in the water.

Thus we see that a determination of the quantity of carbonates, bicarbonates, and hydrates in the boiler feed water will inform the plant engineer how much lime he must use in treating his feed water, and a determination of these same salts in the boiler water will serve as a check on the correctness of his treatment.

In addition to a determination of the carbonates, bicarbonates and hydrates, however, a test should be made to determine the permanent hardness as well, as sulphate scale is exceedingly hard. The permanent hardness must be determined to establish the amount of treatment with soda ash. Some sort of a determination of the total solids, both carbonates, bicarbonates, hydrates, and those which constitute permanent hardness in the boiler water should be made to keep boiler concentrations within proper limits and to determine the correctness of the feed-water treatment.

RAYMOND F. FORBES,
Research Department,
Indianapolis Power & Light Co.
Indianapolis, Ind.

IT HAS been my experience that checking the caustic alkalinity of the treated water with phenolphthalein gives a fair estimate to the chemically uninformed engineer of the alkaline condition of the water. At a feed-water temperature of 200 deg. F. the caustic alkalinity of the soluble carbonates, aside from sodium carbonate, will not be over 1 grain per gallon. Consequently, if a causticity of between 1 and 2 grains per gallon is obtained it indicates a small amount of hydrate, which is excess chemical, there being no hydrates in the raw water. This also indicates that there are no bicarbonates present, since hydrates and bicarbonates cannot be present at the same time.

We now know that the proper excess of chemicals has not been exceeded and that the lime treatment is approximately correct, provided the soda-ash treatment is not too deficient.

It only remains to make a hardness test, with soap, to determine the latter point. If the hardness is about the amount of the caustic reading, or a little more, the soda-ash treatment is correct and the hydrate is present as a sodium hydrate. If the hardness is higher a deficiency of soda ash is indicated, and its amount should be increased, remembering always that as the soda ash is increased the lime must be decreased somewhat to maintain the proper caustic reading mentioned before.

R. T. COLLINGS,
Beveridge Paper Co.
Indianapolis, Ind.

IN MOST feed waters, testing for the bicarbonates is a measure of the temporary hardness, or, in chemical terms, the amount of hardness which is precipitated by heat. With an internal chemical treatment the bicarbonate hardness, consisting of calcium and magnesium bicarbonates, is partially precipitated in the open heater and the remainder in the boiler. In either case, the precipitated material consists of calcium and magnesium carbonates, which form a soft sludge.

With an external treatment, such as a lime-soda ash softener, the bicarbonates of calcium and magnesium are precipitated by the lime as calcium carbonate and magnesium hydrate. These precipitates are largely removed in the sedimentation tank of the softener, the final traces by a sand filter. In a zeolite softener the calcium and magnesium bicarbonates are converted to sodium bicarbonate, which is decomposed to sodium carbonate under boiler pressure. The bicarbonate content in a feed water, therefore, indicates the amount of sludge-producing constituents in an internal treatment, the amount of lime-reacting constituents in a lime-soda ash softener and the amount of sodium bicarbonate formed with a zeolite softener.

The carbonates and hydrates ordinarily refer to sodium carbonate and sodium hydrate in a concentrated boiler water sample. These constituents indicate the amount of softening chemicals in the boiler water, and for boilers operating at 150 to 175-lb. pressure, the total alkalinity necessary to prevent scale formation is approximately 25 grains per gallon. The amount of alkalinity will differ, however, with various feed waters. A low alkalinity will allow for scale formation, while an excessively high alkalinity means an overdose of chemicals, which increases the cost of treatment and may cause a foaming condition. In order to have a definite guide to a feed-water treatment a test for sodium chloride (salt) in the boiler water should also be made. The blowdowns can be governed by the salt test more easily than by the alkalinity test, as the latter may vary according to the amount of scale in a boiler, whereas the salt is non-scale forming and is a true indication of the concentrations of the soluble materials in the feed water. For average conditions, the amount of salt in the boiler water is 15 to 20 times the salt of the feed water before foaming is experienced. This condition also varies with the quality of feed water and existing operating conditions.

When using soda ash as an internal treatment, many boiler operators change the quantity of chemicals according to the scale condition of the boiler when down for cleaning. A test to determine the proper alkalinity can be made by adding 10 to 15 drops of ammonical saturated solution of ammonium oxalate to 20 cc. of boiler water. If a cloudy white precipitate is immediately formed, it indicates that scale-forming material is present, and the soda ash should be increased until no precipitate shows.

When the total alkalinity and sodium sulphate content of the boiler water is obtained, the sulphate to carbonate ratio for the prevention of the embrittlement can be determined. The sodium sulphate content divided by the total alkalinity gives a ratio which should be .014 times the boiler pressure. For example, if the pressure is 160 lb. the total alkalinity as calcium carbonate to sodium sulphate should be 1 : 2.24.

D. C. CARMICHAEL,
E. I. DuPont de Nemours & Co.
Wilmington, Del.

TO TREAT the boiler and feed water intelligently, the plant engineer should know the amount of sulphates as well as the various alkalines contained in the water.

When analyses of both feed and boiler water have been made, the first step is to determine the highest concentration of sodium sulphate that can be carried in the boiler water without causing priming. The next point to decide is the ratio of sodium sulphate to sodium carbonate. The maintenance of this ratio at 2 or 3 to 1 has been found to have an inhibiting effect upon caustic embrittlement of boiler drums and blowdown flanges. A ratio above 3 to 1 is apt to cause trouble from priming. A sulphate-to-carbonate ratio of 3 to 1 and a carbonate concentration of 25 grains per gallon have been found to give good results.

The feed water is treated for hardness in the usual way. The concentrations of carbonates and sulphates in the boiler water are then brought up by adding caustic soda or sodium sulphate as required. The concentrated solutions are pumped into the boiler drums by a small high-pressure pump connected through the gage-glass line. Only two or three hours are necessary for the distribution of the solutions throughout the boiler.

WILLIAM WELCH, JR.
New York City.

A Question for Our Readers

IN OUR system of treating boiler feed waters, we use the usual lime and soda-ash procedure, heating the raw water to 210 deg. F. before treatment. This gives $CaCO_3$, $CaSO_4$ and $Mg(OH)_2$, which are settled out and filtered before the water goes to the boilers.

The steam traps on the lines, after the steam is used in the engines and turbines, show a deposit of scale, which is mainly $CaCO_3$. We do not get deposits in engines or turbines.

The only explanation, I can see for such deposits is that the particles of water carried along with the steam also carry $CaCO_3$ with them. But why this should pass through the engines and deposit in the traps is hard to explain. Perhaps some of your readers could give their experiences in this line.

H.C.N.

Suitable answers from readers will be paid for and published in the Dec. 3 issue.

The Schmidt-Hartmann Boiler

. . . A Reply to Dr. Loeffler

In presenting Dr. St. Loeffler's first article in the March 19 number of *Power*, the editor wrote, "In spite of their controversial nature the author's arguments and comparisons are presented here in the belief that they . . . will lead to worthwhile discussion from interested readers." Such a discussion, somwhat belated, is presented here. It is hoped that this clash of opinions of engineers with avowed special interests will at least redirect the attention of American engineers to the high-pressure boiler problem.

By O. H. Hartmann
Technical Director,
Schmidt'schen Heissdampf Gesellschaft, m.b.H.,
Kassel-Wilhelmshöhe, Germany

WITH reference to the article, "Steam Generation at High Pressures and Temperatures," by Dr. St. Loeffler, published in the March 19 number of *Power*, Professor Loeffler made, under the heading "Double Fluid Boilers," some remarks on the Schmidt-Hartmann boiler which cannot be passed over without a reply.

It should first be mentioned that the diagrammatic sketch (Fig. 6 in the article) is incomplete, some of the most essential parts being omitted. For example, the steam-generating tube coil *H* is shown entering the collector *D* at its lowest point, while actually the coil is connected to the collector laterally only a little under the water level, or better, a little above the level, to thoroughly separate the water from the steam.

Downcomers lead this water from the lowest point of the collector *D* back to the lower end of the steam-generating coils for fresh circulation. Thus the steam-generating coils contain a mixture consisting of several times more water than steam, resulting in an excellent cooling effect on the tubes. The condensate cooler *K* is necessary only when an indirect economizer is applied in the circuit of the heating fluid.

A complete diagram of the Schmidt-Hartmann boiler with indirect economizer is shown in Fig. 1. The operation of the boiler will be easily understood from the drawing and the explanation underneath. This type has been built for the Wernigerode trial boiler of the Schmidt'schen Heissdampf-Gesellschaft, m.b.H., Kassel-Wilhelmshöhe, and has operated satisfactorily. A good deal of the scale-forming salts are precipitated in the form of mud in the preheater *b*, which is heated by the hot condensate. Only a small portion of the salts goes through the feed pipe to the boiler drum *a*, where the working steam is generated.

In the stationary boilers indirect preheating has, in consideration of first cost, been given up. The steam-generating tubes only are directly fired. A diagram of this type is shown in Fig. 2.

Professor Loeffler finds fault with the Schmidt-Hartmann boiler, saying that the circulation is not positive. This is wrong. The circulation *is* absolutely positive, and always goes in the same direction. Before building larger boilers, the Schmidt'schen Heissdampf-Gesellschaft made tests with thermal circulation in small tubes, using a 138-ft. coil of 0.87-in. internal diameter. The diameter of the turns was 1.68 ft., the single turns being wound close to one another. This cylindrical coil was coal-fired from the inside. The steam generated, at 1,400-lb. pressure, gave up its latent heat in a second coil lying in a water tank; the condensate returned naturally to the lower coil.

The difference of level between the outlet end of the condensing coil and the upper turn of the heated coal was altered during the tests from $9\frac{3}{4}$ in. to $98\frac{3}{4}$ in. The circulation was unfailing in every position, independently of the height of the water column. This was proved by the fact that the coils were never overheated.

The heating steam was superheated only when the water content of the system was insufficient. This phenomenon was rather surprising, but is explained thus: The heating medium (water or steam) circulates in a pulsatory way, depending on the resistance of the heated coil and on the height of the condensate column. On a working model with a glass drum (which was shown at the 1929 Leipzig Fair), this pulsating action was made visible. These tests gave evidence that even long-tube coils can be used in boilers with thermal circulation when properly arranged.

Only after these experiments was the first trial boiler built. The heating coils were 44.6 ft. long; later boilers had coils 52.5 ft. and 91.8 ft. long. Even with the longer, the circulation is perfectly safe without any auxiliary device. The circulation adapts itself automatically to the load of the boiler. It is worth mentioning that, owing to the excellent heat transfer at the heating surface inside the drum, any variations of the heating pressure are instantaneously transmitted to the contents of the boiler drum.

Professor Loeffler says that with the Schmidt-Hartmann boiler the heating pressure is bound to increase heavily with rising working pressures, even when the heating coils are perfectly clean. There is, of course, a certain

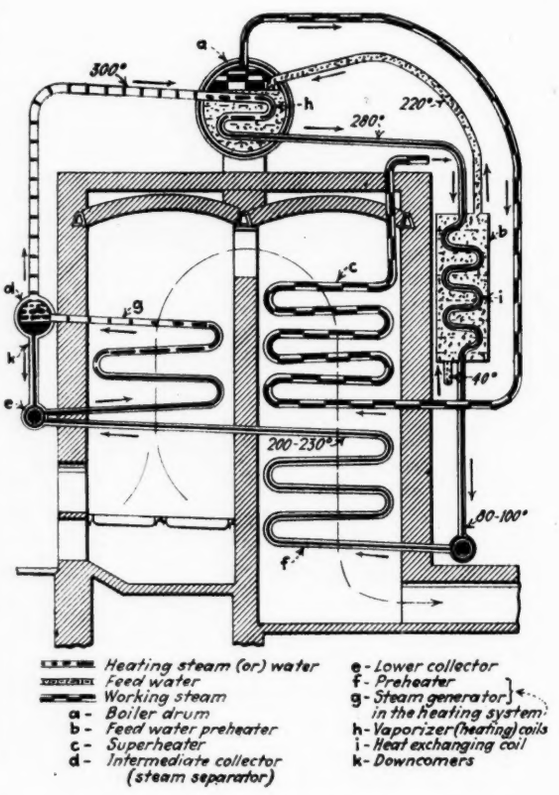


Fig. 1—Diagram of a Schmidt-Hartmann high-pressure boiler with indirect heating

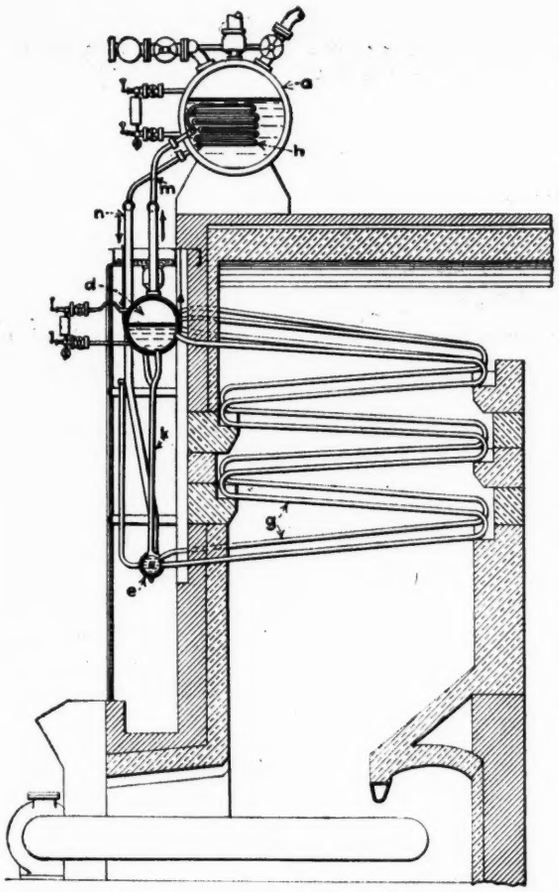

a - Boiler drum
d - Intermediate collector (steam separator)
e - Lower drum
g - Steam generator
h - Vaporizer (heating) coils
k - Downcomers
m - Steam pipes to the heating coils
n - Condensate pipes from the heating coils

Fig. 2—Diagram of a Schmidt-Hartmann indirect-heating boiler without economizer

difference of temperature and also of pressure between the heating steam and the working steam, but the designer is free to choose the relation of heating pressure to working pressure. With small heating surfaces in the drum the heating pressure will, of course, get higher. The pressure chosen should be such that the first cost of the boiler will not be unduly high.

Professor Loeffler then says that steam generation will be strongly affected even by very light scale deposits. This is erroneous; no scale is formed at all on the steam-heated surfaces in the drum. The salts contained in the feed water form only a muddy deposit on the heating units, and this in the lower part of the drum. The mud on the units impairs but slightly the heat transfer, and can easily be removed by a jet of water. Experience with many different feed waters has long since disproved the objections of Professor Loeffler.

Further, Professor Loeffler says that the problem of attending to the coils within the drum is not simple, or that these coils have the further disadvantage of reducing the available water space as well as the steam passage. But it is a most remarkable quality of this system that the working steam is very dry, quite in contrast to the Loeffler system, where, because of the large quantities of superheated steam blown in, the water in the drum is whirled up and some of it entrained in the steam going to the superheater.

He maintains also that the water level in the drum has to be kept practically constant. This is equally erroneous, for with properly dimensioned boiler drums the heating surface can be located so low that a considerable part of the volume, between highest and lowest water level, lies above the vaporizer; besides, even if part of the heating surface extends above the water level it will cause but a small increase in the heating pressure. The heating coils have, of course, to be sufficiently strong for a certain increase of the pressure; although the tube walls are not heavy, small-diameter tubes only being used.

Professor Loeffler goes on to say that two water levels have to be watched constantly, on the drum *a* and on the intermediate collector *d*. But experience has shown that it is not necessary to have a water level on the collector *d*. It is sufficient to measure the temperature of the heating steam. As long as the heating system is saturated, sufficient water is in the heating system. The steam in the upper coils would become superheated only if a considerable quantity of water should be lost by leakage, and the steam collector and part of the coils should be without water. Measuring the temperature of the heating steam is therefore a simple and safe means of checking the water content of the heating system. As a loss of water can be caused only by leakages and thus can amount to but a fractional percentage of the hourly output of the boiler, it will take several hours for the superheat to rise and endanger the boiler, allowing sufficient time, in case of such a leak, to refill the heating system by a small pump.

Finally, Professor Loeffler says that the working of the boiler cannot be controlled. On the contrary, there is no other type of boiler that can be controlled so well. All connections are outside the gas path. Hence, every small leak is at once noticeable. The primary system can, as explained above, be accurately controlled by measuring the temperature of the heating steam. The measuring instrument itself (a distance-reading thermometer) can be arranged in the superintendent's office, where he can follow the operation of each boiler from his desk. Besides, it is possible to determine from the pressure in the heating system how far the heating elements in the drum may have become covered with mud.

The Schmidt-Hartmann boiler has a great advantage over the Loeffler boiler: The fire-heated coils remain perfectly free from scale, because the heating system is filled with pure water and because this water circulates automatically and continually, within a closed system, without any pump. With the Loeffler boiler, on the other hand, the large quantities of steam blown into the boiler water by a circulating pump are likely to bring, together with the entrained water, scale-forming salts to the superheater, which will form an incrustation in the superheater or will go as a fine powder to the turbines.

The best proof of the satisfactory working of the Schmidt-Hartmann system of indirect heating is the fact that at present the following plants are working, or are under construction:

One boiler for 4,400 lb. per hour output, 925-lb. working pressure and 840 deg. F., at the test plant of the Schmidt'schen Heissdampf-Gesellschaft at Wernigerode.

One boiler for 33,000 to 39,700 lb. per hour, 1,420-lb. working pressure and 810 deg. F., at the I. G. Farbenindustrie A.G. plant at Bitterfeld, erected by the Schmidt'schen Heissdampf-Gesellschaft.

One boiler for 55,000 lb. per hour, 925-lb. working pressure and 778 deg. F., at the I. G. Farbenindustrie A.G. plant at Dormagon, built by Hanomag, Hannover-Linden.

One boiler for 66,000 lb. per hour, 925-lb. working pressure and 788 deg. F., second order for the Dormagen plant, with the Hanomag, Hannover-Linden.

One boiler for 66,000 lb. per hour, 925-lb. working pressure and 660 deg. F., for the French Mine de Vicoigne, Noeux et Drocourt, ordered from Buttnerwerke A.G., Uerdingen.

Two experimental marine boilers for 925-lb. working pressure, nearing completion.

One high-pressure locomotive for the German Reichsbahn, for 850-lb. working pressure, built by Henschel & Sohn A. G., Kassel, in service.

Further, there are under construction, for 850-lb. working pressure:

One high-pressure locomotive for the Paris-Lyon-Mediterranee Railway, built by Henschel & Sohn, Kassel.

One high-pressure locomotive for the London, Scotch and Midland Railway, built by the North British Locomotive Works, Glasgow.

Two high-pressure locomotives, American and Canadian railways.

This list of Schmidt-Hartmann boilers is far more extensive than that of the Loeffler system.

THE DEPARTMENT OF COMMERCE, through its advisory committee on manufactures, is doing all possible to insure the collection of more accurate, timely, and practical data on the operations of American industry. These census reports to the government are absolutely confidential under the law, and no manufacturer need hesitate to give the government the operating information it requires.

Eliminating Hazards in Refrigerating Plants

Pitfalls in the path of operation and how to avoid them. The safe path is threefold, embracing correct design and equipment, reliable personnel and proper operating methods.

IN A paper before the Eighteenth Annual Safety Congress, held in Chicago from Sept. 30 to Oct. 4, A. J. Authenrieth, vice-president of the Middle West Utilities Company, analyzed safety from the production angle of the refrigerating plant, stressing design and equipment, operating methods and personnel. The refrigeration industry was not among the first to recognize the advances that had been made in the safety movement. Up to the past year the industry apparently placed its trust in some supernatural safeguard, and as a result paid tribute in accidents—numbered out of all proportion to the hazard of the work. These accidents were more numerous in the handling than in production of ice. There were a number of points on which attention must be focused to eliminate all hazards. Under design and equipment, the author's suggestions were as follows:

When the plant is constructed, all moving machinery offering hazards to its operators should be protected by covers and guard rails. A modern direct synchronous motor-driven compressor, and most motor-driven direct-connected equipment, has this protection worked into the design. In the case of belt-driven equipment, protection must be added when the machinery is set. Flywheels, pulleys, and belts should be inclosed in guard frames substantially constructed. Reciprocating parts that protrude from the body of a machine should be inclosed in the same manner. Idlers should be anchored with a chain permitting the necessary limited motion but preventing their being thrown back off the belt and over the pulley.

Means are provided by designers of heavy machinery for attaching lifting rings or hooks. Ammonia compressors, for instance, have holes tapped and drilled in heavy cylinder heads and crankcase covers. When the plant is erected the builders should finish the job and install I-beam clamps and rings, or other permanent attachments suited to the building design, for hanging hoisting equipment for work on the machinery.

Guarding Electrical Equipment

The development of electrical equipment has reached a point where proper design and assembly eliminates hazards. The backs of switchboards should be guarded by screens. This will keep unauthorized persons out and impress maintenance men with the fact that they are entering dangerous territory and must be on their guard. Proper grounding of the supports is essential. A rubber mat should be placed in front of the board for the operator to stand on.

Electrical conductors liable to personal contact should be well insulated. In an ice plant, no voltages should be considered low. Damp conditions multiply the hazards attending accidental contact. A pair of rubber gloves and shields, in good condition, should be kept in an accessible place.

If it is at all possible, primaries, or high-voltage supply lines, should be led directly away from the plant building and not along its side or over the roof. Transformers and their attachments should be inclosed or placed out of reach above ground.

No plant should be placed in operation that has not been provided with adequate, well-placed lighting. Present plans should be studied with a view toward lighting improvement. Proper lighting will pay for itself by better housekeeping and better morale among the workers, in addition to lowering the operating hazards.

Ammonia presents a well-recognized possible hazard in the ice plant, yet its operating pressures are low, and leaks make their presence known quickly. The effect of concentration in the air is such that the operator will be led to repair a leak with all possible speed. Small leaks around rods and valve stems are sometimes neglected because of the belief that a little smell in the air hurts no one, and "the place is then more like an ice plant anyway." Such an atmosphere, though bearable, may be a breeder of chronic bronchial catarrh. Thus safety as well as economy demands that ammonia systems be tight when placed in service, and be kept that way.

Leaks and breaks can be eliminated, first, by proper hanging and bracing of the pipe, and, second, by the use of proper gaskets. Excessive vibration causes crystallization and failure of the piping. Cross-anchoring should be used, in addition to the usual supports, where it is necessary to eliminate vibration. Rubber and lead gaskets, except in some specialized applications, are rarely as permanent or as satisfactory as asbestos-base gaskets. The first two will frequently crystallize or work out under pressure, and ultimately cause a leak.

Overpressure relief, or safety valves, is now standard equipment on all new installations. Installations that are not so protected should be equipped at once. The valves usually are applied to the condenser with a cut-off between the vessel protected and the relief valve, to permit closing of the line for work on the relief valve. The stop valve should be locked in an open position when not in use for this purpose. The safety valve should be piped to discharge outside, and, if it is outside, should have a nipple screwed in its discharge to prevent rain from entering and causing rust.

Eliminating Personal Injury

Personal injury from falls is always a possibility where there are varying elevations. A wet floor and steps or worker's shoes add to the hazard of falling. The remedy is, first of all, guard rails around raised platforms and on steps. Floors should be well drained, and drip pans should be placed under cold pipes to catch condensation drippings. Oil drips should be caught in cups or pans, not allowed to run over the floor.

Steps should always be installed, except where lack of space demands the use of permanent ladders. Wood railings should be avoided, since they are less permanent and not so trim in appearance. Proper arrangement of the dip tank and dump will do much to eliminate the possibility of someone falling in. Guard rails should be placed at the side of the dip tank, if it constitutes a hazard. The selection of proper personnel and keeping unauthorized persons off the tank will practically eliminate these hazards.

Fire Prevention

General methods of reducing fire risks, such as keeping clean and oily waste or rags in cans and providing fire extinguishers are well known. Although a well-built plant has few fire hazards, the designer and builder must be on guard to minimize any that do exist. Lubricating or fuel oil and gasoline for stand-by equipment should not be placed close to electric motors, because of the motors' liability to overheat or spark. Gasoline or oil lines should be as short as possible and should be protected against vibration or rupture.

Good housekeeping also reduces fire dangers. From the beginning the engine room should be provided with bins and racks for tools and fittings and for storing material. This will permit, and be an incentive toward good housekeeping. Such provisions are necessary because tools will not be kept in good condition and arrangement unless a place is provided. Hazards are increased by the use of defective and unsuitable tools. Then too, plants that look disordered do not promote the proper spirit among the workmen, nor do they make for the best relations with the public.

Promoting Sanitation

Necessities and obligations entailed in obtaining a non-contaminated product in an ice plant were given by the author quoting, verbatim, his company rules on this point.

"Cleanliness and sanitation must be

the first consideration in an ice plant. Ice is a food product; its purity must be maintained. The following instructions must be observed:

"Plant workmen must wear clean, neat, close-fitting clothes.

"Avoid all contact with water that is to be frozen; pushing cans in place with the foot will not be tolerated.

"Drop tubes, filling and sucking nozzles and air tubes must be placed on racks, not laid on tank tops.

"Mop can covers regularly. Never allow enough water to accumulate on can covers to drip into cans.

"Pullers must change their shoes or rubbers when beginning and ending a watch. Shoes worn outside the plant must not be worn when pulling ice. Castor oil applied once weekly will keep the shoe uppers soft and pliable.

"Dip tanks and storage rooms must be kept clean.

"Spitting in the plant shall not be tolerated.

"The property surrounding the plant must be free from dirt, trash and anything unsanitary.

"Chemicals for water treatment should be kept in storage bins provided for that purpose.

"It is the duty of the chief operator to see that tools and spare parts are kept in their proper places.

"Oil and water must not be allowed to accumulate on the engine room floor. Cans must be provided for oily waste, which should be burned periodically.

"Weekly inspection of the plant must be made by the chief operator, who will note any improvements or unsatisfactory condition on a signed and dated card, which will be placed on the bulletin board until the next inspection. The inspection should include all tools used by employees, machinery, safety devices, etc."

Regarding personnel, the author stated that it was an oft-repeated truism that there was no safety device so effective as a careful man. A safe workman eliminates many of the hazards of a given engine room, while a careless man multiplies the hazards of the same room. In other words, personnel was the second integral part of hazard elimination, so that it was important to employ engineers and tank men who realized the responsibility to themselves and their plant to work carefully and safely. Given the proper production force and the normal safeguards, two of the three prime requisites of safe operation were secured.

Everyone in the plant should wear safety-toe shoes. Clothing should be clean and neat and not loose in fit, because a torn sleeve may be caught in the machinery. The best plan is to have the plant force in a standard uniform.

Under correct methods of operation, it was the author's contention that the supervisory force in each plant should formulate safe and efficient operating practice for every routine task. Such tasks as were repeated only at intervals should be assigned to one person familiar with the safe operating practice and that person should be held responsible for the work. Such jobs as draining oil from separators, cleaning condensers and filling grease cups fall in this class. Electrical work should be assigned to, and performed only by, those who are familiar with the correct method. This rule should cover the changing of fuses, opening and closing of transformer cutouts, and maintenance on oil switches, motors, and starting equipment. Defective electrical equipment must be repaired properly and without delay.

Details of operating method should be worked out by the plant superintendent for each plant. He should see that they are put in force.

RECENT PUBLICATIONS

MEASUREMENT OF PIPE FLOW BY THE CO-ORDINATE METHOD. By F. W. Greve. Bulletin No. 32. Engineering Experiment Station, Purdue University, Lafayette Ind. 1928. Paper, 6x9 in.; 31 pages.

THE co-ordinate method of measuring pipe discharge, discussed in this bulletin, depends upon the principle that a definite relation exists between the rate of flow within a horizontal pipe and the co-ordinates of the stream issuing therefrom.

At six-inch horizontal intervals from the end of a 40-ft. horizontal pipe, vertical measurements to the upper surface curve of the jet were made. With the distance out from the pipe as abscissa and the distance from the top inner surface of the pipe to the upper surface of the stream as ordinate, formulas expressing the relation were deduced.

Where instruments such as venturi meters, pitometers and other water meters would be impractical due to suspended matter in the water, it is shown to be possible to determine the flow easily and inexpensively by this method in all cases where a maximum error of 10 per cent is permissible. Empirical formulas and tabulated values of the rate of discharge derived from the experimentation are contained in the bulletin.

FESTSCHRIFT. By Prof. Dr. A. Stodola, Zum 70. Geburtstag. Published by Orell Fussli, Zurich and Leipzig, Germany. Paper; illustrated; 6½ x 9 in.; 602 pages. Price, $5.

THIS volume, a compilation of technical papers prepared by friends and students of Prof. A. Stodola, was presented to him on the occasion of his 70th birthday. It contains 63 technical papers on turbines and kindred subjects, most of which are in German, one in English and a few in French. The introduction contains a short biography and a list of articles and books that he has written. Writing for *Mechanical Engineering* on the book, the man and the occasion, George A. Orrok, consulting engineer, says:

"Among the names of the contributors one finds A. Einstein, Föppl, Honegger, Jacob, Kraft, Havlicek, Loren , Mollier, Nusselt, Prandtl, Schüle and others, experts in different fields. The articles are extremely interesting by their condensed form, which necessitates an unusually high standard of mathematical treatment.

"The question of turbine blading has been dealt with by J. Acheret, Colombi, Darrieus, Dubois, Flatt, Loesel, Seippel. The thermodynamics has been covered by Jacob, Havlicek, Miskovsky, Mollier, Nusselt, Schüle, Zerkowitz. Considerable work is shown on vibration and on strength of turbine parts. Especially interesting is Honegger's paper on thermal stresses. The experimental work on Diesel engines, locomotives, turbines and internal-combustion turbines is also well represented.

"This book should be included in the library of all who are interested in the design, construction and operation of turbines as a sequel to and completion of Stodola's monumental work on the steam turbine. The book sells for $5, the proceeds going to Dr. Stodola as a birthday present."

ENERGIE UND ENERGIEWIRTSCHAFT (Energy and the Economics of Energy) By F. Brock. Published by the Oster-reichisher Ingenieur und Architekten Verein, Vienna, Austria, 1929. Paper; 6¾ x 9 in.; illustrated; 39 pages. Price, 90 cents.

PRINTED in German, this booklet is a revised and enlarged edition of a paper read at the 80th anniversary of the Austrian Engineering and Architectural Society, entitled "Energy Problems and Their Prospects."

Beginning with an historical analysis of the theory of energy, as set forth by Mayer, Thomson and Helmholtz, the fundamental concept of energy and the law of the conservation of energy, as interpreted by Robert Mayer, are fully explained. Forms of energy such as heat, mechanical motion, electricity and chemical action, and the transformation of energy, are discussed in detail. The available natural sources of energy are also analyzed.

The modern economics of the use of coal and water as sources of energy and their relation to population and food supply, as brought out in Professor Penck's 1924 report to the Prussian Academy of Sciences, are discussed. On this is based a calculation of the period of time through which these energy resources will last.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

UNDISCOURAGED *by ten years of failure, Congress is preparing to take up Muscle Shoals legislation again at the December session, when an effort will be made to re-pass the bill providing for government operation of the properties, which was pocket-vetoed by President Coolidge last year.*

* * *

UTILIZATION *of electric power by industry consumes about 96,000,000,000 kw.-hr. annually at a cost of nearly $2,000,000,000, according to figures made public recently by the Department of Commerce.*

* * *

IN VARIOUS LINES *of power-generating machinery exports of steam engines declined sharply, but foreign sales of boilers and internal combustion engines rose substantially, and those of steam specialties increased 72 per cent during the first eight months of 1929, according to reports of the Bureau of Foreign and Domestic Commerce.*

* * *

GASOLINE *refined from shale oil developed 4.03 per cent more horsepower than the product of oil wells in dynamometer tests recently conducted by the Bureau of Mines in co-operation with the University of Colorado.*

* * *

THAT THE WATER-POWER *problem of New York State should be taken out of the hands of the politicians and power companies and placed under the direction of unbiased business leadership was recommended by the Committee of Twenty-five in its current report. The committee was appointed last April at the New York state-wide economic congress to consider state economic and industrial questions.*

* * *

ERECTION *of a dam and hydro-electric plant near Drevers Mill on Jackson River, ten miles north of Covington, Va., was announced Oct. 22 by the Virginia Public Service Company of Richmond. The project will involve an expenditure of between $2,000,000 and $3,000,000.*

Decision Reached in Power Allocation at Boulder Dam Plant

Public and Private Interests on Fifty-Fifty Basis According to Plan Announced by Secretary Wilbur—Objections to Be Considered at Hearing, Nov. 12

PUBLIC agencies and the utilities are equal beneficiaries under the plan for allocation of Boulder Dam power announced on Oct. 21, by Secretary of the Interior Wilbur following a series of conferences with the applicants that extended throughout the preceding week. The representatives of the Southern California Edison Company regard the plan outlined by Secretary Wilbur as tentative, and will be prepared to present further arguments regarding several features of the matter at the hearing, which has been assigned for Nov. 12. As outlined by Secretary Wilbur the power to be developed at the dam, subject to certain deductions, is to be contracted for as follows:

The metropolitan water district of Southern California, 50 per cent, or so much thereof as may be needed and used for the pumping of Colorado River water.

To the City of Los Angeles 25 per cent; and

To the Southern California Edison and associated companies, 25 per cent.

These allotments are to be subject to certain deductions which may arise through the exercise of preference rights, i. e., (*a*) not exceeding 18 per cent of the total power developed for the State of Nevada for use in Nevada; (*b*) not exceeding 18 per cent of the total power for the State of Arizona, for use in Arizona, as above; and should either of the States not exercise its preference rights the other may absorb them up to 4 per cent; (*c*) not exceeding 4 per cent for municipalities which have heretofore filed applications.

All such preference rights in whole or in part are to be exercised by the execution of valid contracts with the respective States and municipalities satisfactory to the Secretary, and the exercise of such preference rights is to reduce proportionately the above allotments to the district, the city and the company.

Any state desiring to withdraw power within the limitations above stated must serve on the Secretary of the Interior written notice within not less than twelve months of the amount of power desired, and for the purchase of which valid contracts satisfactory to the Secretary must be executed.

Power contracted for but not required within a state shall be allocated to the city and company on a 50-50 basis, with the reservation that it can again be called for within a reasonable time for use within the state. All power provided a state shall be at actual cost.

Should the 50 per cent allocated to the metropolitan water district be not required for pumping, this shall become available to the city of Los Angeles, 66⅔ per cent; to the Southern California Edison and associated companies, 33⅓ per cent.

Any municipalities desiring the power within the limitation prescribed must execute the necessary contract therefor within twelve months from the date the contracts are made with the district, the city and the company.

Any firm power available at the Boulder Canyon Dam for the payment of which other contractors do not become and remain liable, aside from that allocated to the metropolitan district, shall be taken and paid for by the city of Los Angeles and the Edison company on a 50-50 basis.

The contract for the available power is to be made with the city of Los Angeles, and the metropolitan water district, with various sub-contracts assuring the above, and providing for a board of control made up of two members nominated by the city of Los Angeles and the metropolitan water district, two by the Southern California Edison and associated companies, and one by the Secretary of the Interior, to act with the city of Los Angeles in the operation of the plant.

The federal government will install the dam, tunnels, power houses, and penstocks. The machinery for the generation and distribution of power is to be provided and installed by the lessee. The costs of installation and operation are to be borne by those contracting for the power in proportion to the amounts received. When the dam and power house are actually in operation the lessees may have the right to ask for a review of the actual cost of units of power and be entitled to deductions, which will still permit the charge made to return to the government all advances and interest in accordance with the Boulder Dam Act, and provided further

that if such review indicates that a higher rate should be paid for power to meet the obligation to the federal government such an advance in rate will be put into effect.

There will be a clause inserted in all of the contracts which will insure the distribution of all power developed at the Boulder Dam at such a price as in the opinion of the Federal Power Commission is fair to all consumers. Should certain municipalities operating their own power plants desire to make separate agreements with the city of Los Angeles and the metropolitan water district they shall be supplied with power at cost price.

Great Shannon Power Scheme Nearing Completion

Harnessing of the River Shannon to the extent of 52,000 hp. for the production of electricity will be completed during the winter months, according to recent reports. The flow of the Shannon will henceforth be converted into current for lighting homes and dispensing power all over the Irish Free State at 2c per kilowatt-hour.

To concentrate the power available—and almost all the 110-ft. descent of the Shannon is utilized—enormous constructional works have been necessary. A barrage to hold up 25 ft. of water has been made across the course of the river, some four miles below Lough Dearg. This barrage consists of six sluice gates, although the conventional term hardly conveys an idea of their magnitude. Four of them are each 59 ft. wide, and the other two are 38 ft. high. The waterway, 7½ miles long, 37 ft. deep, and 300 ft. wide, is a ship canal in proportions, and, in fact, is big enough to carry the largest ship afloat.

These constructions, colossal though they be (170,000,000 cu.ft. of rock and soil were removed to make the headrace) are but the preliminary works. The power house has been designed for nearly 250,000 hp., to be generated by six turbines. At present only three are installed. The pipes leading from the headrace above convey an idea of the pent-up energy that is released and converted into power more than do the turbines themselves. Twenty feet in diameter, only three feet less than the ordinary London subway station and sufficiently wide to permit four automobiles to be driven abreast through them, they are only 144 ft. long. In this short distance 100 ft. of useful head of water is obtained. This mighty power working within the space of a few feet, if out of hand, is capable of great damage and requires special control. Consequently, not only do the normal devices regulate the water as the load demands, but other emergency arrangements also insure the complete stoppage of the flow in the case of urgent necessity. Normally the operation of opening or closing the sluices occupies a period of about fifteen minutes, but, should need arise, they can be shut in half a minute.

Monument to Pelton, Inventor of Waterwheel

To mark the place where Lester A. Pelton perfected his famous hydraulic invention of 1878, a monument recently was erected in the little old mining town of Camptonville, Calif., on the site of his workshop. The monument is of concrete, 11 ft. high, and is surmounted by one of his early waterwheels. A bronze tablet on the face of the shaft reads, "On this spot in 1878 Lester Allen Pelton invented the Pelton Water Wheel—Erected 1929 by Gravel Range Lodge No. 59, Free and Accepted Masons." The tablet was donated by W. M. White, manager of the hydraulic department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Pelton Monument

The story of the inventor and his life work is a vital chapter in the history of the hydraulic mining period in California. Few facts are known of his early life before he crossed the plains from Ohio to California in 1850. After several unsuccessful business ventures, including an attempt at mining, he established himself as a millwright in Camptonville, Yuba County. There he worked for years erecting mills and mining machinery, including a number of the early "hurdy-gurdy" type of impulsive waterwheels in common use in the mining districts at that time. Impressed with the possibility of improving the efficiency of this wheel by introducing a split bucket, it is related that he worked all the winter of 1878 in a nearby stream experimenting with different bucket shapes made by hand from tin cans. For the next two years he continued to experiment and made at least one trip to Berkeley, where additional tests were made and a model constructed at the University of California. After securing a patent on his invention, in 1880, the wheel was introduced to the public, and several years later he moved to San Francisco, where the Pelton Water Wheel Company was formed. With this organization, which had acquired his patent rights, he worked for years as a consulting engineer. Mr. Pelton died in 1910 at Oakland, Calif.

In 1895 the Franklin Institute published an exhaustive report on the Pelton wheel and awarded the inventor the Elliott Cresson medal, rating the invention among the foremost contributions to scientific progress.

Trade Commission Inquiry Delayed by Utilities

Withholding by several large utility companies of pertinent records relating to important mergers, together with delay of some of the large holding companies in answering the Federal Trade Commission's comprehensive questionnaire, are slowing up activities in the financial phases of the investigation of power and gas utilities. Certain large holding companies have failed to submit answers to the questionnaire in a number of important instances where answers had actually been prepared by their subsidiaries, it is made known in the commission's seventeenth interim report of progress.

These delays are occurring in spite of the fact that the investigation is being pressed with as much expedition as the capacity of the present staff of employees will permit. The appropriation of funds now available does not make possible the employment of additional accountants, the commission declares, and the need of the services of additional accountants is manifest if the investigation is to be carried on with the desired expedition.

Offices of twelve electric and gas companies in various parts of the country were visited in the last three months by examiners seeking to develop facts with respect to the growth of capital assets and capital liabilities and the costs of the charges of service companies.

Steam Plant to Be Erected by Milwaukee Company

Further additions to the power facilities of the Wisconsin-Michigan group of subsidiaries of the North American Company will result from a new steam electric generating plant to be built by the Milwaukee Electric Railway & Light Company at Port Washington, Wis., 28 miles north of Milwaukee. The project involves an initial investment of about $8,000,000 and ultimate expenditure of more than $25,000,000. Initial installation is planned for a capacity of 60,000 to 75,000 kw., to be increased ultimately to 300,000 kw. The proposed site is on the shore of Lake

Who Wants Money to Burn?

A CHANCE for some enterprising power plant to acquire really expensive fuel free of charge occurred recently when the United States Treasury Department had money to burn but no place to burn it. Approximately two tons of retired currency was slated for destruction, but the proper furnaces were not to be had at the Bureau of Engraving, where the money is made. Machines that masticated the bills into a pulpy substance were used formerly, but these were not altogether satisfactory.

What to do! The money had to be done away with. The job had to be done thoroughly to remove any temptation that would be caused by partial destruction. Happily, someone thought of the Navy Department, which has control of ample furnaces at the Washington Navy Yard and elsewhere. A hurried telephone conversation between department heads revealed that the navy would do the job—with reservations. The Navy would not be responsible for any misadventure. Any expenses for the installation of new equipment such as gratings over the chimney to prevent partially burned bills from flying away would have to be borne by the Treasury Department.

Won't some beneficent power plant engineer help the Treasury Department out the next time it has money to burn?

Michigan, with convenient harbor facilities for coal and water supply.

Construction activities will begin next spring, contingent upon legislative cooperation by the city of Port Washington. The company also proposes to purchase the Port Washington municipal distribution system and to put into effect residence and industrial power rates substantially lower than present municipal rates. Growth of industry, particularly on the north side of Milwaukee, is given as the chief reason for increased power facilities. The Port Washington plant will be similar in operating characteristics to Lakeside plant, which is now being enlarged to bring its capacity up to 310,000 kilowatts.

Electric output of the North American Company's subsidiaries for the 12 months ended Sept. 30, 1929, was 6,650,000,000 kw.-hr., an increase of 12.6 per cent over the output for the preceding 12 months' period of the same companies in the five groups of subsidiaries operating in California, District of Columbia, Missouri-Illinois-Iowa, Ohio, and Wisconsin-Michigan.

News of Canada

New Steam Plant for Nova Scotia—Winnipeg to Extend Heating System—Addition to Vancouver Plant—B. C. Corporation Buys Kamloops Power System

REPORTS from Nova Scotia state that the Dominion Coal Company, a constituent company of the British Empire Steel Corporation, Ltd., has awarded a contract to the United Engineers and Constructors, Ltd., Montreal, for the design and construction of a steam power station, to be built on tidewater at Glace Bay, N. S. This plant is of ultra-modern type, with a 7,500-kva. steam turbine-generator, completely equipped with boilers and all auxiliary apparatus. The boilers are to operate at 450 lb. pressure, and are to utilize pulverized coal, giving the highest efficiency under present steam power station practice.

Heating System Extension

The Public Utilities Committee of the city of Winnipeg, Manitoba, has received a recommendation from the manager of the civic hydro-electric system that a bylaw be submitted to the ratepayers at the forthcoming civic elections asking for authorization to spend $300,000 on a major extension to the present steam-heat distribution plant, $225,000 being required for the plant itself and $75,000 for the distribution system. The extension to the plant calls for a new boiler, with accessories, and an extension to the building.

Remodeling Vancouver Plant

Plans for a $1,000,000 expansion in plant have been announced by the British Columbia Electric Railway Company. The expenditures projected are in connection with bringing in the new power supply which will be available to Vancouver on completion of the new hydro-electric plant at Ruskin, on Stave River. The expenditure projected includes remodeling the Burnaby substation at a cost of $220,000 and building two parallel high-tension power lines from Ruskin to Burnaby, at a cost of approximately $750,000. The substation will be enlarged and equipped with devices necessary to cut the voltage from 60,000 to 34,600 for redistribution.

Kamloop Plant Purchased

Marking another step in the British Columbia Power Corporation's gradual acquisition of the important power plants of the province, the company recently succeeded in negotiating for the purchase of the Kamloops system for $600,000. There was competition for the power franchise at Kamloops earlier in the year, several companies filing bids which were not accepted. The B. C. Power Corporation executed a surprise move, however, when President W. G. Murrin appeared on the scene and offered $600,000, which is considerably in excess of any previous tender.

Burros Make Power Plant Possible

THOUGH not usually identified with anything as dynamic as power, the meek and lowly burro played a major rôle in the erection recently of a modern hydro-electric plant near Las Truchas, Mexico. All equipment for the plant, whose capacity is 1,350 kva. at a 1,200-ft. head, was carried to the site on the backs of these little animals over difficult mountain trails. Each trip took ten days. The pipe line, nearly 4,000 ft. in length, was cut into sections of from 3½ to 6 ft. long, depending upon the weight. A single section was carried by each burro. Even at that, the job was completed in nine months.

Many New Boilers Being Installed

Many new boiler installations are in progress at the present time in connection with new plant construction and the modernization of old power houses. Among those of particular interest is the installation in the Ashtabula plant of the Cleveland Electric Illuminating Company. Here, six new boilers, with a total of 195,360 sq.ft. of heating surface, are being placed. Fired by the Lopulco pulverized-fuel system, these units will generate approximately 2,700,000 lb. of steam per hour.

The tendency toward higher pressures is apparent in the installation of three 10,000-sq.ft. Springfield boilers to operate at a pressure of 500 lb. in the power plant of Anheuser-Busch, Inc., of St. Louis. Another is the placing of two 8,500-sq.ft. boilers of the same make to operate at 600 lb. in the plant of the West Virginia Pulp & Paper Company at Tyrone, Pa. A third is the installation of four Springfield boilers, with a heating surface of 20,000 sq.ft., in the Manteno State Hospital, Ill., which when completed will be the largest insane hospital in the United States.

Fairbanks Morse Wins Tilt With Texas Power Co.

An appeal by the Texas Power & Light Company to the Supreme Court seeking to uphold its injunction restraining Fairbanks, Morse & Company from interfering with its contracts in Texas municipalities has been denied. The Texas power company complained that the Fairbanks, Morse company had endeavored to sell power-generating equipment to Commerce, Seymour, and other cities in northern Texas by conspiring to induce the power company's customers to discontinue their contracts

and to negotiate with the cities for their supply of current.

The United States District Court for northern Texas granted an interlocutory injunction. Upon appeal by Fairbanks, Morse & Company, the Circuit Court of Appeals for the Fifth Circuit set aside the restraining order. It is this decision of the Circuit Court of Appeals ordering the injunction removed that the Supreme Court has sustained by refusing to review the case.

The brief of the power company states that the company has a franchise to generate, sell and distribute current in Texas and has a contract with the city of Commerce and other Texas cities for the sale of current. The lower court, according to the power company, was in error in allowing the Fairbanks, Morse company to carry out agreements with the cities to deliver and install plant, machinery and equipment, and to accept as payments monthly warrants payable out of net operating profits.

A.I.E.E. Power Group to Begin Second Year, Oct. 30

With a meeting to be held on Oct. 30 the Power Group of the New York section of the A.I.E.E. will begin its second season of activity. The group is the outcome of a plan adopted last spring to divide the membership of the New York section into power, communication, transportation and illumination groups, each handling its own meetings and general affairs and the four groups uniting for monthly meetings as before. The formation of the Power Group has made possible programs of specific interest to the members connected with the power field and more general discussion, particularly by the younger members.

On Oct. 30 the subject of the group will be generation and the development of generators, with papers by H. C. Forbes and C. M. Gilt. On Dec. 9 the group will discuss system connections, on March 11 high-tension transmission cable, and on May 13 high-tension overhead transmission. Meetings will be held in Room 1 of the Engineering Societies Building at 7:30 p.m.

V.P.I. Receives Gift of Steinmetz Curio Cases

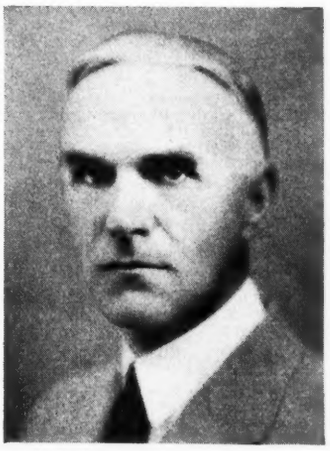
Two large display cases which once held curios collected by Charles P. Steinmetz, electrical genius, are now the property of the Virginia Polytechnic Institute electrical engineering department, at Blacksburg, Va. The cases, shipped from Schenectady, N. Y., arrived recently at Patton Engineering Hall.

The gift, regarded as invaluable, was made by J. R. L. Hayden, formerly secretary to Mr. Steinmetz and now administrator of his estate, through John P. Palmer, V.P.I. graduate in 1903, and now electrical engineer for the railway department of the General Electric Company.

Gibson Now Chief Engineer of Buffalo Niagara Co.

Norman R. Gibson, former vice-president and chief engineer of the Niagara Falls Power Company and inventor of a method for measuring the flow of fluids in closed conduits, has been appointed vice-president and chief engineer of the Buffalo, Niagara & Eastern Power Corporation, Buffalo.

Born at Guelph, Ont., March 23, 1880, Mr. Gibson attended the public schools and was graduated from the



Norman R. Gibson

University of Toronto with honors in 1904. He immediately took a position as draftsman with the Ontario Power Company, at Niagara Falls. In 1906, he became designer and assistant hydraulic engineer of the Point du Bois power development for the city of Winnipeg, Manitoba. Subsequently, he took charge of the hydraulic department of Smith, Kerry & Chace, consulting engineers.

From 1913 until 1915 Mr. Gibson was retained by the Ontario Power Company and the Electric Power Company, Ltd., of Toronto, as consulting engineer. In 1915 he was made chief engineer of the Electric Power Company. From 1916 to 1917 he served as assistant chief engineer of the Ontario Company.

His first connection with the Niagara Falls Power Company was in February, 1918, when he became hydraulic engineer of the Hydraulic Power Company and subsequently the Niagara Falls Power Company. From February, 1925, until February, 1926, he was executive engineer, and in February, 1926, was made chief engineer. In August, 1926, he was made vice-president and chief engineer of the Niagara Falls Power Company.

Mr. Gibson invented "the Gibson Method and Apparatus for Measuring the Flow of Fluids in Closed Conduits," patented in the United States, Canada and foreign countries. He is also the author of the papers, "Pressures in Penstocks Caused by the Gradual Closing of Turbine Gates," which appeared in *Transactions* of the A.S.C.E., and "Niagara Power," given in the proceedings of A.S.C.E.

Water-Tube Boilers Maintain 1929 Gain in 3rd Quarter

New orders for 1,909 steel boilers were placed in September, as reported to the Department of Commerce by 80 manufacturers, comprising most of the leading firms in the industry, as compared with 1,859 boilers in August and 1,749 in September, 1928. The following table presents the number and square footage of each kind of boiler ordered for the first nine months of 1929, including comparisons with the corresponding period last year.

	Total 9 Mos., 1929		Total 9 Mos., 1928	
	No.	Sq.Ft.	No.	Sq.Ft.
Stationary				
Water tube...	1,339	7,692,059	1,062	5,193,864
Horizontal return tubular.	1,102	1,458,504	1,174	1,473,755
Verticle fire tube.....	1,204	361,559	1,274	376,896
Locomotive (not railway)	223	176,041	302	196,741
Steel heating.	9,087	4,249,506	9,552	4,697,384
Oil country...	855	872,816	671	633,019
Self-contained portable.....	450	310,440	525	348,768
Miscellaneous.	126	78,052	117	58,909
Total.....	14,386	15,198,977	14,677	12,979,336
Marine				
Water tube...	69	273,705	79	379,255
Pipe.....	8	9,057	1	1,881
Scotch.....	71	63,295	94	48,315
2 and 3 flue...	2	1,350	11	4,347
Miscellaneous.	9	12,213	4	3,998
Total.....	159	359,620	189	437,796
Grand total	14,545	15,558,597	14,866	13,417,132

Soft and Anthracite Coal Production Increases

The total production of soft coal for the country as a whole during the month of September is estimated at 44,515,000 net tons as against 43,889,000 tons in August, according to a recent report of the Bureau of Mines. The average daily rate of output in September was 1,832,000 tons. Compared with the average daily rate for August, this shows an increase of 12.7 per cent.

The production of anthracite in the State of Pennsylvania during the month of September amounted to 6,792,000 net tons, an increase of 838,000 tons, or 14.1 per cent, over the output in August. The average daily rate of production in September was 283,000 tons, an increase of 62,000 tons, or 28.1 per cent, over the daily rate for August.

The total production of soft coal during the week ended Oct. 12, including lignite and coal coked at the mines, is estimated at 11,584,000 net tons. Compared with the output in the preceding week, this shows an increase of 474,000 tons, or 4.3 per cent. Production during the week in 1928 corresponding with that of Oct. 12 amounted to 11,274,000 tons.

The total production of Pennsylvania anthracite during the week ended Oct. 12 is estimated at 1,956,000 net tons. Compared with the output in the preceding week, this shows a decrease of 23,000 tons, or 1.2 per cent. Production during the week in 1928 corresponding with that of Oct. 12 amounted to 2,003,000 tons.

Bok Advertising Award Announced

Again the Harvard Advertising Awards Committee of the National Industrial Advertisers Association is announcing the annual Bok award of $2,000 for the best industrial advertising campaign for 1929 appearing in newspapers and periodicals. Closing date of this competition is Dec. 31, 1929. Every industrial advertiser is eligible to enter this competition, and will find that a consideration of the requirements alone will tend to inspire higher standards in industrial advertising.

To enter competition for this award, the industrial advertiser must submit a manuscript describing the campaign, its functions, and its application, together with reproductions of the ads as they appeared and a statement of the analysis of the market on which the campaign was founded. The manuscript and the ads must be submitted in certain prescribed form, the details of which can be secured direct from Harvard Graduate School of Business Administration (Harvard Advertising Awards), Soldiers' Field Station, Boston, Mass., or from A. H. Oberndorfer, chairman N.I.A.A. awards committee, Sivyer Steel Casting Company, Milwaukee, Wis.

Coming Conventions

American Institute of Electrical Engineers. District meeting at Chicago, Ill., Dec. 2-4. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting at New York, N. Y., Dec. 2-6. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Twenty-Fifth Anniversary Meeting at Hotel Pennsylvania, New York City, Dec. 4-7. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

Stoker Manufacturers Association. Fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Nov. 11-13.

Obituary

Wallace S. Clark, for many years head of the wire and cable division of the General Electric Company, died suddenly at his home in Schenectady, N. Y., on Oct. 11. Mr. Clark was one of the pioneers of the electrical industry, and his service in it began in September, 1885, when, shortly after his graduation from Sheffield Scientific School, Yale University, with the degree of Ph.B., he entered the commercial and engineering offices of the Edison Electric Light Company in New York City. He went to the Schenectady works of the Edison General Electric Company in February, 1887; the company had moved to that city the previous fall. He entered the wire and cable department of the company in 1891, and in 1903 was made superintendent of the wire and cable, underground tube and varnish departments. In July, 1904, he was made engineer of the wire and cable department, and was also in charge of sales for the department. With the formation of the central station department in 1924, he was made manager of the wire and cable division.

Champ S. Vance, vice-president of the Los Angeles Gas & Electric Corporation, died suddenly Oct. 11 in his Los Angeles office from a heart attack. He was 65 years of age. Mr. Vance had been associated with the Los Angeles Gas & Electric Corporation for more than 30 years. In 1898 he entered the employ of the Los Angeles Lighting Company, one of the predecessors of the present lighting corporation, as a solicitor. Shortly after that he became chief solicitor, later special agent, and then manager of operation. In 1913 he was made vice-president and a director of the company, the position he occupied at the time of his death.

John Wendell Robinson, central station manager of the northwest district, Westinghouse Electric & Manufacturing Company, recently succumbed to heart trouble. Mr. Robinson had been with the sales organization of the Westinghouse company for 23 years. He started in 1906 as a lamp salesman in the Milwaukee office, and since then had worked in detail and supply sales, general sales, railway and lighting sales, and central station sales departments all in the Milwaukee office. In 1922, Mr. Robinson assumed the executive duties of central station sales manager for the northwest district, which position he held until the time of his death.

Personals

Harry H. Hunt, formerly president of the Stone & Webster Service Corporation, has been elected chairman of the board of that company. George H. Clifford succeeds Mr. Hunt as president. Mr. Clifford has been with the Stone & Webster organization 28 years, having been initially employed by the Northern Texas Traction Company at Fort Worth, Texas. Later, he became division manager of the Virginia Electric & Power Company properties and properties in the Southwest, which position he held up to the present.

Alex Dow, president of the Detroit Edison Company, represented the American Society of Mechanical Engineers at the celebration in honor of Thomas A. Edison, held at Dearborn, Mich., Oct. 21.

Arthur H. Myers has accepted the position of assistant supervising engineer with the Research Corporation of Bound Brook, N. J. Mr. Myers has been employed by the New York Edison Company for the past eleven years, ten of which were spent as assistant to George A. Orrok, consulting engineer.

M. H. Marshall of the Dominion Power and Reclamation Service, Department of Interior, Canada, is now resident inspection engineer for the department at the Island Falls power development in Saskatchewan.

W. S. Lea, consulting engineer, of Montreal; W. S. Scott, commissioner of Greater Winnipeg Water District; and W. P. Brereton, city engineer of Winnipeg, have been appointed to represent the city of Winnipeg in connection with the hydro-electric development at Slave Falls.

Rex P. Johnson, formerly with the Ontario Hydro-Electric Power Commission on the Queenstown-Chippawa development and later with the Detroit Edison Company, has recently joined the staff of the Rust Engineering Company, at Pittsburgh, Pa.

George W. Hawley, of Berkley, Calif., has been appointed by Governor Young of California to administer the state dam inspection act, which was passed by the last legislature. He will be deputy in the Division of Water Resources, headed by Edward Hyatt.

F. R. Bussler, for the past seven years general superintendent for the Wooster (Ohio) Electric Company, has been named superintendent of construction of the Eastern New Jersey Power & Light Company, Asbury Park, N. J., for the Management & Engineering Corporation of Chicago. Mr. Bussler is succeeding Gordon Miller, who is assuming new duties in Indianapolis.

Business Notes

General Refractories Company, Philadelphia, Pa., has just announced the appointment of the Desch Supply & Equipment Company, 16 South Frederick St., Baltimore, Md., as its high-temperature cement dealer representative for the State of Maryland and for Washington, D. C.

Combustion Engineering Corporation announces the opening of a district office at Room 606, 1411 Fourth Ave., Seattle, Wash. George M. Bechtel, recently of the Los Angeles office, has been appointed branch manager.

Diamond Chain & Manufacturing Company, Indianapolis, Ind., has appointed L. A. Benson & Company, of Baltimore, distributors of its products in the Baltimore district.

Ohio Injector Company, Wadsworth, Ohio, has started work on an addition to its plant. The new four-story building will measure 280 x 340 ft., and will be used for the manufacture of brass and iron valves. It is expected to be ready for production shortly after the first of the year.

A. P. Green Fire Brick Company, Mexico, Mo., has appointed H. R. Williams, 1701 North Illinois St., Indianapolis, Ind., specialty representative for Indianapolis and for the State of Indiana.

Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces the appointment of A. D. Brown as district manager of its Buffalo office to succeed M. W. Phelps, resigned. Mr. Brown was formerly associated with the New York office of the Pittsburgh Transformer Company, a division of the Allis-Chalmers company.

Trade Catalogs

Meters—Bulletin No. 871-A of the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., gives a complete description of the L & N generator field temperature recorder. This instrument measures and records the temperatures in a rotating field of a generator. The booklet illustrates the principle and application of the recorder with diagrams and photographs.

Lubrication—"Houghton on Industrial Plant Lubrication" is the title of a 56-page illustrated booklet recently issued by E. F. Houghton & Company, P. O. Box 6913, North Philadelphia, Pa. The bulletin contains chapters on the theory of lubrication, uses of various oils and greases, lubricants for the power plant, the effect of temperature on lubricants, and the relation of correct lubrication to plant efficiency.

Pumps—Bulletin 295 issued by the Byron Jackson Company of Berkeley, Calif., describes the company's type S, double-suction, single-stage, horizontally-split-case, centrifugal pumps. Many illustrations of construction details and actual installations are included in the 22-page booklet.

Refractories—"Firebond" is the title of a 12-page booklet recently published by the Harbison-Walker Refractories Company of Pittsburgh, Pa., which describes that company's high-temperature cement. New and useful tables for calculating the quantities of brick required for arches of different spans and thicknesses are included in the publication.

Electric Controllers—Allen-Bradley Company, Milwaukee, Wis., has just brought its complete catalog of electric controlling apparatus up to date, with the issue of a loose-leaf booklet which contains extensive data on motor starters, controllers, rheostats, battery-charging equipment, and motor accessories for all types of installations. More than 70 illustrated bulletins with handy index tabs are included in this complete publication.

Oiling Devices—William W. Nugent & Company, 410 N. Hermitage Ave., Chicago, Ill., have just issued the second edition of their bulletin No. 15, which gives extensive information on oiling and filtering systems, telescopic oilers, crank-pin center oilers, sight-feed valves, oil pumps, and many other oiling devices. The 48-page booklet is profusely illustrated.

With the Society Sections

A. S. M. E., Cleveland Section. Meeting Nov. 4, Cleveland Engineering Society rooms at 8 p.m., with the student branch at the Case School of Applied Science. Dr. W. E. Wickenden, president of the Case School, will give a general talk.

A. S. M. E., Metropolitan Section. Power meeting, Nov. 8, sponsored by the power division of the A. S. M. E.; chairman, Dr. Harvey N. Davis, president of Stevens Institute of Technology. Subject: "Recent Developments in European Power Plants," by Joseph H. Keenan, professor of mechanical engineering, Stevens Institute.

A. S. M. E., San Francisco Section. Meeting, Nov. 7, Engineers' Club of San Francisco, at 7:30 p.m. Subject: "Licensing of Engineers," by L. F. Levrey, W. Stalder, C. H. Snyder and J. D. Galloway. These speakers are to give their ideas pro and con.

A. S. M. E., Worcester Section. Meeting, Nov. 7, C. T. Sherer Company's restaurant, at 6:30 p.m. Subject: "The General History of Mechanical Refrigeration," by F. L. Fairbanks, chief engineer of Quincy Market, Boston, Mass.

A.I.E.E., New York Section. Power Group meeting Oct. 30, at the Engineering Societies Building. Subject: Generation and the development of generators.

National Research Council. Committee on electrical insulation of the Division of Engineering and Industrial Research will hold annual meeting at Massachusetts Institute of Technology, Cambridge, Mass., Nov. 14-16.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.10 @ $2.45
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.25 @ 2.50
Smokeless	Chicago	2.10 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.40 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.10
Big Seam	Birmingham	1.50 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.65@ 2.75
Barley	New York	1.40@ 1.50

FUEL OIL

New York—Oct. 24, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Oct. 11, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.5959 per bbl. or 42 gal.; 26@28 deg., $1.6459 per bbl.; 28@30 deg., $1.6959 per bbl.; 30@32 deg., $1.7459 per bbl.; 32@36 deg., gas oil, 4.901c. per gal.; 37@40 deg., distillate, 5.98c.

Pittsburgh—Oct. 16, f.o.b. local refinery, 30@34 deg., fuel oil, 4c. per gal.; 36@40 deg., 4.25c. per gal.

Philadelphia—Oct. 18, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Oct. 22, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Oct. 9, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 95c.@$1.00 per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Oct. 21, tank-car lots, f.o.b., 12@14 deg., Baume 4.5c. per gal.; 28@32 deg., 5.62c. per gal.

Dallas—Oct. 19, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., El Centro—Imperial Irrigation Dist., plans an election soon to vote $2,000,000 for the installation of a Diesel electric generating plant.

Calif., Los Angeles—Central Ice & Cold Storage Co., 6360 Compton St., awarded contract for the construction of a 129 x 150 ft. ice plant to Gay Engineering Co., 2650 Santa Fe Ave. Estimated cost $40,000.

Calif., Los Angeles — Eugene Stark, J. M. Schenck & Associates, is having preliminary plans prepared for the construction of a 12 story apartment building, including steam heating, electric refrigeration systems, electric elevators, etc., at Hollywood Blvd. and Fuller Ave. Estimated cost $1,000,000. C. Beelman, 1019 Union Bank Bldg., is architect.

Calif., Modsto—County of Stanislaus, received lowest bid for the construction of a hospital ward building and power house, from G. Swanstrom, 1723 Webster St., Oakland, $44,795. R. G. deLappe, 1710 Franklin St., Oakland, is engineer.

Calif., San Clemente—City Council, will receive bids until Nov. 6 for the construction of a sewage system including three sewage pumping plants. Estimated cost to exceed $25,000. W. A. Ayer is City Engineer.

Calif., Whittier—City plans an election Nov. 19 to vote $310,000 bonds for extensions and improvements to water system, including wells, pumping plants, etc.

Kan., Ellis—City awarded contract for the construction of a power plant including 350 kw. oil engine, new switchboard, etc., to J. F. Prichard & Co., 528 Dwight Bldg. Estimated cost $68,000.

Ind., Indianapolis—Atlantic & Pacific Tea Co., 209 West South St., awarded contract for the construction of a 3 story, 105 x 400 ft. warehouse including cold storage plant, etc. at State and Willard Park to Moynahan Construction Co., 170 Union Title Bldg. Estimated cost $250,000.

La., Baton Rouge — Standard Oil Co. of Louisiana and Louisiana Steam Products, Inc., subsidiary of Engineers Public Service Co. under management of Stone & Webster, 49 Federal St., Boston, Mass., plan the construction of a steam and electric power plant near here to supply 6,000,000,000 lbs. steam annually, electric generating plant to have 60,000 hp. capacity. Estimated cost approximately $6,000,000.

La., Shreveport — City plans an election Dec. 17, to vote $500,000 bonds for waterworks improvements including pumping station, at Cross Lake.

Mich., Grosse Pointe Park—Dept. of Public Works, City Hall, is having preliminary plans prepared for the construction of a sewage pumping station at Cadieux and Mack Aves. Estimated cost $150,000. P. A. Fellows, City Hall, is engineer.

Minn., Granite Falls—Northern States Power Co., 15 South 5th St., Minneapolis, is having plans prepared for the construction of a steam power plant, 20,000 kw. capacity, also high pressure transmission line near here. Estimated cost $2,500,000. Private plans.

Miss., Meridian—State Building Commission, W. C. Trotter, Secy. Jackson, awarded contract for the construction of a group of hospital buildings including power house, service building, etc. to Garber & Lewis, Jackson. Estimated cost $98,105.

Mo., Rolla — Gasconade River Power Co., 1015 Baltimore Ave., Kansas City, has been granted permit to construct a hydro-electric development including dam 1,750 ft. long and 110 ft. high on the Gasconade River west of Rolla in Phelps County, 50,000 hp. total capacity. Estimated cost approximately $10,000,000.

Mo., St. Louis—St. Luke's Hospital, R. D. S. Putney, Supt., awarded contract for the construction of a 61 x 103 ft. power plant to Gamble Construction Co., 620 Chestnut St.

N. H., Warren—New Hampshire Sanatorium, R. W. Deming Supt., awarded contract for the construction of a hydro-electric power station to Robie Construction Co., 999 Elm St., Manchester. Estimated cost $40,000.

N. J., Bound Brook—Calco Chemical Co., Inc., awarded contract for the construction of a 40 x 50 ft. addition to boiler room on Bound Brook Rd. to Wegton-Abbott Co., 552 West 23rd St., New York.

N. J., Jersey City—Pennsylvania R.R. Co., Pennsylvania Station, New York, awarded contract for the construction of an 8 story, 230 x 900 ft. cold storage plant and warehouse at Hudson River and Exchange Pl. to F. H. McGraw, Inc., 51 East 42nd St., New York. Estimated cost $1,000,000. Pennsylvania Dock Co., 25 Church St., New York, is lessee.

N. J., Newark—United Color & Pigment Co., Evergreen Ave., awarded contract for the construction of a boiler house to W. G. Sharwell & Co., 377 North 5th St. Estimated cost $40,000.

N. Y., New York—Dept. of Parks, received lowest bid for the construction of a steam boiler plant, coal conveyor, etc. for power house and service building for American Museum of Natural History, Columbus Ave. and 77th St. for Gillis & Geoghegan, Inc., $444,000.

Pa., Safety Harbor — Safe Harbor Water Power Corp., has filed application for approval of construction of hydro-electric plant on Susquehanna River. Dam will be approximately 2/3 of a mi. in length, foundations of power house 1,048 ft. long, initial superstructure 500 ft. long containing six main generating units. Total capacity 230,000 hp. Ultimate total capacity 500,000 hp. Total estimated cost approximately $30,000,000. Contract for the construction of dam and power house awarded to Arundel Corp., Pratt St., Baltimore, Md.

Pa., Philadelphia — American Ice Co., 121 North Broad St., will soon award contract for the construction of a 143 x 148 ft. ice manufacturing plant at Limekiln Pike and 18th St. A. C. Borger, 717 Walnut St., is architect.

Tenn., Jackson—City plans the construction of a new power plant. Burns & McDonnell, Engineering Co., 402 Interstate Bldg., Kansas City, Mo., are engineers.

Tex., Brownsville — Cameron County Water Improvement Dist. No. 13, H. Nunn, El Jardin Hotel, voted $500,000 bonds for irrigation project including pumping unit, etc. H. L. Livingston, Battler Bldg., San Benito, is engineer.

Tex., Coleman—O. D. Dillingham, Abilene, plans the construction of a 20 ton ice plant at Commercial Ave. and Second St., here.

Tex., San Antonio—U. S. Government, A. W. Parkers, Constructing Quartermaster, awarded contract for the construction of barracks buildings, 2 warehouses, etc. including refrigeration plant, at Randolph Field to Murch Bros. Construction Co., Railway Exchange Bldg., St. Louis, Mo. $1,227,000.

Tex., Yoakum — Swift & Co., 115 South Medina Ave., San Antonio, will soon receive bids for the construction of a 76 x 120 ft. cold storage plant, here.

Wash., Wenatchee—Washington Electric Co., subsidiary of Puget Sound Power & Light Co., A. W. Leonard, Pres., Stuart Bldg., Seattle, has been granted permit to construct a power project at Rock Island near here to develop 84,000 hp. of electric energy. Estimated cost approximately $10,000,000 to $12,000,000.

B. C., Vancouver — British Columbia Power Corp., plans expenditure of $50,000,000 on power development within next six years including development of Bridge, Ruskin and Campbell Rivers. Total capacity of Bridge River project, 750,000 hp.; development of tunnel connecting Bridge River with Seton Lake 70 per cent completed. Ruskin development ultimate capacity 188,000 hp., 47,000 hp. will be brought into service in about a year.

Heerlen, State of Limber, the Netherlands—Staatsmynen in Limberg, Heerlen, c/o F. K. Th. Van Iterson, Owner and Director, is having plans prepared for extension to steam generating plant at Maurits Collery to include extension to boiler house, equipment to consist of two water tube boilers with superheaters, air heaters, fans, dust eliminators, pulverized coal handling equipment, etc. Estimated cost $950,000. L. D. Royer, 911 Smith-Young Tower Bldg., San Antonio, Tex., is consulting engineer.

Equipment Wanted

Electric Generator and Engine — Dept. of Mental Hygiene, Capitol, Albany, N. Y., will receive bids until Nov. 13, for electric generator and engine for Middletown State Homepathic Hospital, Middletown, N. Y.

Power Plant Equipment—East Bay Municipal Utility Dist., J. H. Kimball, Secy., Oakland, Calif., will receive bids until Nov. 4 for equipment for El Cerrito booster plant at 22nd and Adeline Sts.

Pump, Motor, etc.—City of Toronto, Ont., S. McBride, City Hall, Mayor, will receive bids until Nov. 5, for a 10,000,000 imperial gal. centrifugal pump and electric motor for Riverdale pumping station. Estimated cost $10,000.

Industrial Projects

Colo., Pueblo — Fleetcraft Airplane Corp., acquired a 150 acre tract near municipal airport and plans the construction of a factory. Estimted cost $500,000.

Mich., Detroit — Hayes Body Corp., 551 Seventh St. N. W., Grand Rapids, will soon award contract for the construction of a 3 story, 75 x 570 ft. factory on Muskegon St. Estimated cost $260,000. Pearson & Fett, South Bend, Ind., are engineers. Electric motors and equipment for the manufacture of metal bodies for automobiles will be required.

Mich., Detroit—Hoskins Mfg. Co., 4435 Lawton Ave., awarded contract for the construction of a 1 story addition to factory on Lawton Ave. to Hazleton Clark Co., 1038 Michigan Theatre Bldg. Estimated cost $40,000. Electric motors and miscellaneous equipment for the manufacture of electric furnaces will be required.

Mich., Detroit—U. S. Aluminum Co., 3311 Dunn Rd., will soon award contract for the construction of a 1 story, 100 x 380 ft. factory for the manufacture of aluminum products. Estimated cost $75,000. Private plans.

Mich., Flint—A. C. Spark Plug Co., Harriet St., is having plans prepared for the construction of a 3 story, 100 x 160 ft. addition to factory. Estimated cost $125,000. Private plans. Additional equipment for ceramic department will be required.

Mich., Lansing—Fisher Body Corp., General Motors Bldg., Detroit, is having plans prepared for a 2 story, 72 x 450 ft. factory on Division St. here. Estimated cost $250,000. H. E. Beyster, 9-261 General Motors Bldg., Detroit, is engineer. Equipment for handling and finishing automobile bodies will be required.

N. J., Belleville—Westinghouse Electric & Mfg. Co., 150 Broadway, New York, will soon award contract for a 2 story electric manufacturing plant here. Estimated cost $150,000. J. H. and W. C. Ely, 605 Broad St., Newark, are architects.

N. J., Edgewater—A. Kahn, 1000 Marquette Bldg., Detroit, Mich., Archt., will receive bids until Oct. 28 for the construction of a 2 story, 360 x 1,500 ft. assembly plant, including boiler and oil houses, etc., at River Rd. and Hudson River here, for Ford Motor Co., Highland Park, Mich. Estimated cost $1,000,000.

N. J., Newark—Senatron Tube Co., 57 State St., will receive bids about Nov. 15 for the construction of a 6 story, 68 x 120 ft. factory for the manufacture of radio tubes at 78-82 8th Ave. Estimated cost $175,000. Siegler & Greenberg, 164 Market St., are architects.

O., Massillon—Central Alloy Corp., plans extensions and improvements to mill to include continuous pack and pair furnace and electric drive equipment here, also a normalizing furnace at Canton. Estimated total cost $600,000.

Pa., McKeesport — National Tube Co., 71 Broadway, New York, N. Y., G. G. Goe, Frick Bldg., Pittsburgh, Local Agt., subsidiary of U. S. Steel Corp., will build two seamless tube mills, one open hearth mill and one bar mill here. Estimated cost $20,000,000. J. J. Boax, c/o owner, Frick Bldg., Pittsburgh, is chief engineer. Work under way on foundations and erecting steel.

Tenn., Alcoa — Aluminum Co. of America, Oliver Bldg., Pittsburgh, Pa., will build an alloy plant here. Estimated cost $2,000,000. Work will be done by separate contracts. Structural steel contract awarded.

Ont., St. Catharines — Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland, O., manufacturers of automobile accessories, has work under way on the construction of a manufacturing plant including boiler house, etc. at St. Paul St. W. Estimated cost $100,000. Private plans. Equipment for the manufacture of bolts, nuts, cranks and metal parts for automobiles and airplanes will be required.

Russia — Union Soviet Socialist Republica, c/o Amtorg Trading Corp., 261 5th Ave., New York, N. Y., awarded contracts for the construction of a tractor factory here to McClintic-Marshall Co., Oliver Bldg., Pittsburgh and electric power station to Westinghouse Electric & Mfg. Co., Lang St. and Pennsylvania R.R. Pittsburgh. Estimated cost to exceed $5,000,000.